

RBFS User Guides

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1. Overview Guides

1.1. RBFS CLI Overview

1.1.1. RBFS Command Line Interface

RBFS CLI Overview

RBFS command line interface is a primary user interface that enables you to interact with RBFS for monitoring, configuring, debugging, and maintaining the system. RBFS command line interface, that runs on top of the Debian shell, provides a rich set of commands which allow you to execute various operations on the system.

RBFS CLI commands are organized in hierarchies based on their functionalities. Commands, which are used to execute the same type of functions, have the same hierarchy. For example, to display information, you can use commands that start with 'show'. Delete command, in RBFS, is used to remove an existing configuration.

The RBFS command-line interface has three modes: Configuration mode, Operation mode, and Debug mode.

Operational mode: This is the default mode of RBFS command line interface. Operational mode allows you to execute the operational commands such as show commands to view or monitor various system configuration and its current state.

Configuration mode: Configuration mode allows to execute various configurations for services or features. It also allows you to view the information for the existing configurations.

Debug mode: It allows you to execute troubleshooting or debugging operations in the RBFS system.

Using the CLI

The following are some of the utilities which help you working with the CLI faster and easier.

Complete Partially Typed Commands:

You can press Tab key to complete a partially typed command. It helps you work with commands faster.

Command Options and Description:

If you do not know the options available for a command and the purposes of the options, you can enter the question mark symbol (?). It displays all the available command options and descriptions for that commands.

In any of the modes, if you type the question mark symbol (?), the CLI displays a set of commands which can be executed in that particular mode.

When you execute configurations through CtrlD, and then with the Command Line Interface, it results in error when you commit the configuration through the CLI. The reason is that CtrlD directly interacts with the backend applications (BDS and CONFD) and these changes are not synced with the CLI.

Launching the RBFS CLI

The following example shows how to start the RBFS CLI.

```
supervisor@rtbrick>LEAF01:~$ cli
supervisor@rtbrick>LEAF01: op>
```

'op>' shows you are in operational mode.

CLI Prompt

This section introduces you to three types of prompts:

- **RBFS CLI prompt**: The RBFS CLI prompt is the command-line interface (CLI) used to interact with the RtBrick FullStack (RBFS) software. Upon logging into RBFS, you will see the CLI prompt in Operational State mode. To switch to a different mode, see the Switching CLI Modes section.
- **Container shell prompt**: The container shell prompt refers to the command-line interface that appears when you access a Linux container environment where RBFS is installed.
- **Host prompt**: The RtBrick Host prompt refers to the command-line interface that appears when using the RBFS software after it is installed.

RBFS CLI Prompt

The RBFS CLI prompt reflects the static hostname and host OS hostname. In RBFS, the static hostname is the container name and the dynamic hostname is derived from DHCP.

The format of the RBFS CLI prompt is as follows:

<username> @ <static_hostname> > <hostname.host-os>: <mode>

Option	Description
<username>	This specifies the user-defined name.
static_hostname	This is specified in the /etc/hostname directory and always corresponds to the container name.
hostname.host-os	This is specified in the /etc/hostname.host-os directory and reflects a DHCP-learned hostname.
mode	This identifies the CLI mode, such as cfg (Configuration mode), op (Operation mode (default mode)), or dbg (Debug) mode. To switch between modes, enter the "switch-mode <mode>" command. For details on switching between modes, see the Switching CLI Modes section below.

Switching CLI Modes

RBFS CLI has three modes: Configuration mode, Operation mode, and Debug mode. You can enter switch-mode command to change the CLI mode.

The following example shows the options available in the "switch-mode" command.

```
supervisor@rtbrick>LEAF01: op> switch-mode ?
    config                Enter a given mode
    debug                 Enter a given mode
    operation             Enter a given mode
```

The following examples shows how to switch between modes and how the CLI prompt changes with each mode.

Switching from operation (op) to configuration (cfg) mode:

```
supervisor@rtbrick>LEAF01: op> switch-mode config
Activating syntax mode : cfg [config]
supervisor@rtbrick>LEAF01: cfg>
```

Switching from configuration (cfg) to operation (op) mode:

```
supervisor@rtbrick>LEAF01: cfg> switch-mode operation
Activating syntax mode : op [operation]
supervisor@rtbrick>LEAF01: op>
```

Switching from configuration (operation) to debug (debug) mode:

```
supervisor@rtbrick>LEAF01: op> switch-mode debug
Activating syntax mode : dbg [debug]
supervisor@rtbrick>LEAF01: dbg>
```

Container Shell Prompt

The container shell prompt reflects the host OS's static hostname and hostname.

The format of the container shell prompt is as follows:

<username> @ <static_hostname> > <hostname.host-os>:<current_directory> $

Option	Description
<username>	This specifies the user-defined name.
static_hostname	This is specified in the /etc/hostname directory and always corresponds to the container name.
hostname.host-os	This is specified in the /etc/hostname.host-os directory and reflects a DHCP-learned hostname.
<directory>	This specifies your current working directory.

Example:

```
rtbuser@rtbrick>LEAF01:~ $ cat /etc/hostname
rtbrick

rtbuser@rtbrick>LEAF01:~ $ cat /etc/hostname.host-os
LEAF01
```

RtBrick Host Prompt

You can log in into RtBrick Host using SSH port 1022, which applies to both in-band and out-of-band access.

The format is as follows:

ssh <user>@<host-ip> -p 1022

Option	Description
<user>	This is the unique identifier you assign to a user account while installing RBFS.
<host-ip>	This specifies the host IP address.

```
ssh rtbuser@192.0.2.0
rtbuser@onl:~ $
```

Turning Paging On/Off

To turn the paging on or off, use the following command:

paging [**on** | **off**]

- off - Pagination will be turned off for the commands that span more than screen length
- on - Pagination will be turned on for the commands that span more than screen length

Example:

```
supervisor@rtbrick>LEAF01: cfg>  paging on
```

Turning On or Off CLI Colors

To enable or disable the colors in the CLI output, use the following command:

color [**on** | **off**]

Example:

```
supervisor@rtbrick>LEAF01: cfg> color on
```

Accessing CLI Logs

RBFS supports sending command history log messages to Graylog, a log management software that enables real-time analysis of log messages.

The command history logs help you to understand which user has executed a specific command across multiple CLI sessions.

The log format for CLI command history logs is: *User '%s' executed command '%s'*.

System logging is implemented for RESTCONF.



For RESTCONF error logs, do not set the log level to 'info'. If you set the log level to info, logs are generated for all the restconfd requests.

Basic CLI Features

Viewing CLI Tree

The show cli tree command displays all RBFS CLI commands and command options that exist.

- show cli tree: This command provides you the list of all RBFS CLI commands and options that are available.
- show cli tree detail: The detail option for the command displays additional information such as minimum and maximum values allowed.

Viewing Command History

The history command enables you to view the previously executed commands. You can execute the command in any of the CLI modes.

history

Example:

```
supervisor@rtbrick>LEAF01: op> history
show config set
exit
show config set
load config test.json
load config obj.json
show config set
exit
show config set
load config test.json
switch-mode config
load config test.json
load config obj.json
exit
switch-mode config
show config set
load config test.josn
load config obj
load config obj.json
exit
show config set
load config obj.json
load config test.json
exit
show bd running-status
load config test.json
show config set
exit
show bd running-status
exi
show datastore confd table test index index2
exit
```

Setting Configuration Parameters

The set command is used to configure parameters.

```
supervisor@rtbrick: cfg> set system ntp server MyNTPServer ipv4-address 10.1.1.100
```

Deleting Configuration Parameters

The delete command is used to remove existing configuration parameters.

```
supervisor@rtbrick: cfg> delete system ntp server MyNTPServer ipv4-address
10.1.1.100
```

Viewing Core Dump Files

When a router crashes, it is useful to obtain a complete copy of the memory image, also known as core dump, to identify the cause of the crash.

The show core-dump stack-trace command displays core dump data generated by the system. It includes information such as Core Dump File Name, Process Name/ID, Time of Core Dump, Core Dump Size, Signal Information, Process State, and so on.

You can use the command in the following ways:

- show core-dump lists the core dump files.
- show core-dump stack-trace displays all the stack traces (list of the function calls) for all valid core files.
- show core-dump stack-trace <file-name> displays the stack traces for a specified file.
- show core-dump stack-trace <file-name> per-thread displays stack trace for all threads for the specified file.



Each process is allowed to retain up to three core files. When a new core file is generated, the oldest file will be automatically deleted. It improves disk space management while retaining recent crash data for debugging.

clear core-dump

- Use the clear core-dump to clear output populated.

Additionally, you can specify a file name to remove core dump data for that file.

clear core-dump <file-name>

Viewing Hardware Resource Usage Limit Information

In RBFS, you can view the hardware resource usage limit details.

Run the following command:

show hardware limits

Example:

```
supervisor@rtbrick>rtbrick.net: op> show hardware limits
Hardware resources:
  Module: fib
    ASIC                              : q2c
    Role                              : accessleaf
    Model                             : agcva48s
    IPv4 route count                  : 1200000
    IPv6 route count                  : 250000
  Module: fib
    ASIC                              : q2c
    Role                              : accessleaf
    Model                             : as7946-74xkb
    IPv4 route count                  : 1200000
    IPv6 route count                  : 250000
  Module: fib
    ASIC                              : q2c
    Role                              : accessleaf
    Model                             : as7946-30xb
    IPv4 route count                  : 1200000
    IPv6 route count                  : 250000
  Module: fib
    ASIC                              : q2c
    Role                              : accessleaf
    Model                             : s9600-72xc
    IPv4 route count                  : 1200000
    IPv6 route count                  : 250000
  Module: bgp
    ASIC                              : q2c
    6PE label                         : 2
  Module: confd
    ASIC                              : q2c
    Max MTU profile                   : 8
    Max L3 MTU profile                : 3
    Max subscriber MTU profile        : 6
    Max physical MTU profile          : 8
  Module: rd
    ASIC                              : q2c
```

Rebooting Containers and Hosts

The reboot command allows you to restart containers and hosts.

reboot <option>

Option	Description
-	Without any option, this command allows you to reboot a container (default). You are prompted to confirm rebooting the container when you enter this command. You must answer yes or no.

Option	Description
container	This command allows you to reboot a container. You are prompted to confirm rebooting the container when you enter this command. You must answer yes or no.
container-and-confirm	This command reboots the container without prompting yes/no.
device	This command allows you to reboot a device. You are prompted to confirm rebooting the device when you enter this command. You must answer yes or no.
device-and-confirm	This command reboots the device without prompting yes/no.

Example:

```
supervisor@rtbrick>LEAF01: cfg> reboot container
```

Viewing System Version Details

To display the version details of RBFS and its various components, use the show version command.

show version

Example:

```
supervisor@ixr_pe1>srv3.nbg1.rtbrick.net: op> show version
UUID        : 2abb4250-2a14-4e5c-84e2-6785eee158f8
Version     : 22.6.0-g4internal.20220620060710+Bfs0000bgpauthlatest.C3abc099d
Role        : spine
Platform    : virtual
Format      : lxd
Build date  : 2022-06-20 06:07:10 UTC
Component                          Version
Timestamp                  Branch
alertmanager                       0.20.1001-
internal.20220613124702+Bdevelopment....       2022-06-07 20:01:29
development
cligen                             0.1.0-
internal.20220613140225+Bdevelopment.C9457c97b     2022-06-07 20:00:33
development
clixon                             4.3.1-
```

```
internal.20220618124913+Bdevelopment.C85593b60     2022-06-13 11:48:32
development
<...>
```

Viewing Date and Time

To display system date and time, use the date command.

date

Example:

```
supervisor@rtbrick>LEAF01: op> date
Thu Apr 28 09:56:32 UTC 2022
```

Viewing the Running configuration

To display the running configurations, enter the show config command.

Example:

```
supervisor@rtbrick>LEAF01: cfg> show config
```

Viewing a Specific Hierarchy

To display the configurations under a specific hierarchy, enter the show config <hierarchy> command.

```
supervisor@rtbrick: cfg> show config ?
  access                Global access configuration
  daemon-options        List of daemon options
  global                Global configurations
  instance              Network instance configuration
  <...>
```

Viewing Configurations in a Specific Format

The show config command displays the current committed configurations of the system. By default, this command displays the configurations in a json format.

show config <format>

You can also specify the format explicitly, if needed. The available display formats are:

- **json**: Display configurations in JSON format
- **set**: Display configurations in CLI format (similar to commands executed)
- **netconf**: Display configurations in XML format
- **text**: Display configurations in textual format (similar to YANG definition)

The following example shows how configurations are displayed in the text format.

```
supervisor@rtbrick>LEAF01: op> show config text
daemon-options {
    instance-name *;
    afi *;
    safi *;
    bd-type bgp.appd;
    bd-name bgp.appd.1;
}
daemon-options {
    instance-name *;
    afi *;
    safi *;
    bd-type bgp.iod;
    bd-name bgp.iod.1;
}
interface {
    name lo-0/0/0;
    unit {
        unit-id 0;
        address {
            ipv4 {
                prefix4 198.51.100.75/24;
            }
            ipv6 {
                prefix6 2001:db8:0:110::/32;
            }
        }
    }
}
<...>
```

To view configurations in the set format, use the show config set command.

Example:

```
supervisor@rtbrick>LEAF01: cfg>  show config set
set interface ifp-0/0/1
set interface ifp-0/0/1 ifp-id 1
set interface ifp-0/0/2
set interface ifp-0/0/2 ifp-id 2
set instance blue
```

```
set instance blue protocol bgp address-family ipv4 multicast
set instance blue protocol bgp address-family ipv6 unicast
set instance red
set instance red protocol bgp address-family ipv4 unicast
set instance red protocol bgp address-family ipv6 unicast
```

Viewing Configuration in a Specified Hierarchy

To view configuration in a specified hierarchy, use the following command:

```
supervisor@rtbrick>LEAF01: cfg> show config set instance red protocol bgp
set instance red protocol bgp address-family ipv4 unicast
set instance red protocol bgp address-family ipv6 unicast
```

Committing CLI Configurations

To apply the configurations, use the commit command.

The following example shows how to commit your changes using the commit command.

```
supervisor@rtbrick>LEAF01:~$ cli
supervisor@rtbrick>LEAF01: op> switch-mode config
supervisor@rtbrick>LEAF01: cfg> <cli command goes here>
supervisor@rtbrick>LEAF01: cfg> commit
```

When you exit CLI configuration with uncommitted changes, a reminder text appears saying that you have changes to commit, as shown in the following example:

```
supervisor@rtbrick>LEAF01: cfg> exit
Uncommitted changes are present
1. Discard the changes and exit
2. Commit the changes and exit
3. Keep the changes and exit [Default behavior]
Enter one of the above choice to proceed :
```

Viewing Uncommitted Changes

To view the uncommitted changes, use the show diff command. The show diff command displays output in JSON format, whereas the the show diff set command displays the output in CLI format.

```
supervisor@rtbrick>LEAF01: cfg> show diff
```

```
supervisor@rtbrick>LEAF01: cfg> set interface ifp-0/0/3 ifp-id 3
supervisor@rtbrick>LEAF01: cfg> set interface ifp-0/0/4 ifp-id 4
supervisor@rtbrick>LEAF01: cfg> show diff set
+set interface ifp-0/0/3
+set interface ifp-0/0/3 ifp-id 3
+set interface ifp-0/0/4
+set interface ifp-0/0/4 ifp-id 4
supervisor@rtbrick>LEAF01: cfg> show diff
 }
+interface {
+    name ifp-0/0/3;
+    ifp-id 3;
+}
+interface {
+    name ifp-0/0/4;
+    ifp-id 4;
+}
 instance {
```

Adding a Configuration Description

An in-line description or comment can be added to a system configuration to describe it.

set system config-description <description>

Example:

```
supervisor@rtbrick>LEAF01: cfg> set system config-description "This is sample test
configuration"
supervisor@rtbrick>LEAF01: cfg> commit
supervisor@rtbrick>LEAF01: cfg> show config
{
  "ietf-restconf:data": {
    "rtbrick-config:system": {
      "config-description": "This is sample test configuration"
    }
  }
```

Saving Configuration

To save configurations, enter the following command:

```
supervisor@rtbrick>LEAF01: cfg> save config my_config.json
```



- Ensure that you use .json at the end of the filename.
- The configuration will be saved to the current working

directory of CLI executable.

Deleting the Entire Running Configuration

The discard command is used to discard configuration changes. To delete the entire running configurations (both committed and uncommitted configurations) at a time, use the discard all command.

Example:

```
supervisor@rtbrick>LEAF01: cfg> discard all
```

Discarding the Uncommitted Configuration

To discard the uncommitted configuration, enter the following command:

```
supervisor@rtbrick>LEAF01: cfg> discard
```

Viewing the Configuration Differences in the Current and Previous Versions

In RBFS, you can view the configuration differences between the current and the previous versions.

show diff <number>

```
supervisor@rtbrick>LEAF01: cfg> show diff 2
 system {
-    secure-management-status false;
+    secure-management-status true;
 }
```

Rolling Back to a Previously Committed Configuration

To rollback to a specific configuration prior to the most recently committed one, use the following command:

rollback <number>

number: Specifies the rollback ID. Range: 1 through 49. 0 refers to the active

configuration, 1 refers to the most recent previous configuration. Default: 1

For example, to rollback to rollback ID 2, use the following command:

```
supervisor@rtbrick>LEAF01: cfg> rollback 2
```

Rolling Back to a Specific Version of Software Configuration

To rollback to a specific version of the software configuration, use the following command:

rollback commit-id <commit-hash>

Example:

```
supervisor@rtbrick>LEAF01: cfg> rollback commit-id
29d5db038c1920fdsdsdsdsdsd323232
```

Loading Configuration

To load configurations, enter the following command:

load config <filename> <option>

The options include merge and replace. You can specify merge after the file name to merge the configuration with the running configuration. Specify replace to replace the running configuration with the new one. Without any option, it replaces the running configuration, by default.

```
supervisor@rtbrick>LEAF01: cfg>  load config <filename>
```



- Ensure that you use '.json' at the end of the filename.
- Remember to commit your changes after loading.

Watch Mode

The watch mode configuration allows users to enable or disable real-time

command monitoring, periodically refresh output (in-place refresh), and highlight changes between updates.

To run commands with watch mode enabled:

1. Set the watch-mode to 'on' and specify the time interval (in seconds) for polling updates.
2. Execute the desired show command.
3. The command output will refresh at the specified interval, highlighting any changes since the last update.

Currently, the watch-mode feature supports the following CLIs that allow users to retrieve various statistics and counter information.

```
show interface statistics
show interface <name> statistics
show hostpath counters
show hostpath shm counters
show l2x statistics <l2x name>
show trap statistics
show trap statistics <trap type>
show resource statistics
show transceiver
show transceiver <interface>
show memory usage
show sensor fan
show sensor power-supply
show sensor temperature
show bgp peer statistics
show bgp peer statistics instance <instance_name>
show bgp peer statistics instance <instance_name> peer <peer_name>
show bgp peer statistics peer <peer_name>
show isis interface statistics
show ldp statistics
show ldp statistics instance <instance-name>
show ldp statistics instance ldp-id <peer>
show address-translation trap statistics
show ospf statistics interface
show policy statistics <bd>
show policy statistics <bd> policy-name <policy_name>
show policy statistics <bd> app-key <app_key>
show acl statistics /trap/rule/ordinal
show dynamic-service statistics
show datastore statistics
show datastore <bd> object-template statistics
show datastore <bd> array-template statistics
show datastore <bd> bd connection statistics peer <peer>
show commit statistics
show redundancy client statistics
```

Syntax:

watch-mode (on | off)
watch-mode time-interval <2-120>

Attribute	Description
watch-mode off	Disables real-time command monitoring. This is the default state.
watch-mode on	Enables real-time command monitoring.
watch-mode time-interval <2-120>	Sets the polling interval in seconds for monitoring command execution. The value must be between 2 and 120 seconds. Default is 2 seconds.

The following example sets the command execution monitoring to 5 seconds.

```
supervisor@S1-STD-2-2015>LEAF01: cfg> watch-mode time-interval 5
supervisor@S1-STD-2-2015>LEAF01: cfg> watch-mode on
supervisor@S1-STD-2-2015>LEAF01: cfg> show memory usage
```

The result of the show memory usage command with watch mode enabled is as follows:



To stop a command running in watch mode, press **Ctrl + C** to interrupt the process.

Managing RBFS Services

Brick Daemons

RBFS microservices architecture allows daemons to serve various complementary functions and provide services.

For example, the subscriber daemon (subscriberd) manages the current subscriber state and is responsible for authentication, authorization, and accounting. The ribd daemon is responsible for route selection, next-hop resolution, tunnel selection and recursion.

There are daemons such as CtrlD (Controller) and ApiGwD (API Gateway) which are part of the RBFS ecosystem. These daemons sit in the middle (on the RtBrick Host) and manage all the communication between the client and backend services running in the container. The API Gateway (ApiGwD) daemon provides a single point access to expose services running inside of the RBFS container.

RBFS daemons and other dependencies are packaged as a Debian 12 Bookworm container. The RBFS container is hosted on the RtBrick Host, an open-source operating system, which can be run on white box switches.

RBFS can perform various roles such as Spine, Leaf, and Multiservice Edge which serve different use-cases. The software images of these various roles contain daemons that are required to serve these roles for their different functions. The RBFS Multiservice Edge software image contains all the RBFS daemons packaged in a container, other roles such as Spine and Leaf include only the daemons which are required to carry out their respective functions.

For example, the Spine RBFS image includes (in addition to other daemons) the interior gateway protocol daemons such as isis.appd, isis.iod, ospf.appd, and ospf.iod which are not required in the Access Leaf image.

Similarly, the Access Leaf image should include daemons (in addition to other daemons) such as subscriberd, l2tpd, pppoed, and ipoed which are not present in the Spine image.

The daemons such as alertmanager, confd, etcd, fibd, hostconfd, ifmd and so on are present in the images of both the Spine and Leaf roles as these daemons are required in both of these roles.

Launching Microservices Dynamically

When the RBFS container starts up, it starts only relevant microservices depending on the image role and platform. This is done to minimize unnecessary resource consumption. In RBFS, there are base microservices and on-demand microservices. RBFS containers will have all microservices installed according to the platform and image role, but not all will be enabled on bootup. Only the base microservices will be enabled and started on bootup. On-demand microservices will only be started when their respective configurations are configured and will stop once all dependent configurations are deleted.

For instance, when the user configures BGP with the CLI command set instance

<instance> protocol bgp local-as <as-number>, the rtbrick-bgp.appd.1 and rtbrick-bgp.iod.1 services will start. And, once the BGP configuration is deleted, "rtbrick-bgp.appd.1" and "rtbrick-bgp.iod.1" will be stopped after 5 minutes (graceful shutdown time).

By default, the following base microservices will be running in the container.

- rtbrick-confd
- rtbrick-etcd
- rtbrick-fibd
- rtbrick-hostconfd
- rtbrick-ifmd
- rtbrick-lldpd
- rtbrick-mribd
- rtbrick-opsd
- rtbrick-poold
- rtbrick-resmond
- rtbrick-resmond-agent
- rtbrick-restconfd
- rtbrick-ribd
- rtbrick-staticd

When you make other RBFS configurations, the required on-demand microservices will be automatically enabled.

Listing All Available Services

To list all available RBFS services, enter the following command:

```
sudo systemctl list-unit-files | grep "rtbrick-"
```

Starting or Stopping the Services

To start or stop a specific RBFS service, enter the following command:

```
sudo service <service> start|stop
```

Restarting a Service

To restart a specific RBFS service, enter the following command:

```
sudo service <service> restart
```

Example:

```
supervisor@onl>multiservice-edge.rtbrick.net:~ $ sudo service rtbrick-ctrld
restart
```



- In the unlikely event of a failure in a daemon, the service will restart automatically.

Verifying the Status of a Service

To verify the status of a RBFS Service, enter the following command:

```
sudo service <service> status
```

For example, to check the status of the rtbrick-pppoed.1 service, enter the following command:

```
supervisor@onl>multiservice-edge.rtbrick.net:~ $ sudo service rtbrick-pppoed.1
status
```

Removing the Committed/Uncommitted Configuration

To discard the both committed and uncommitted configurations, enter the following command:

```
supervisor@rtbrick>LEAF01: cfg> discard all
```



Exeuting the discard all command will remove your committed configurations. Users will receive a warning indicating that it will permanently remove all committed configurations. A confirmation prompt shows the message providing an explicit [yes/no] option

for the user to choose before proceeding.

Example:

```
supervisor@rtbrick.net: cfg> discard all
Warning: This action will discard all committed configurations.
Are you sure you want to proceed? [yes/no] [Default: yes]: no
supervisor@rtbrick.net: cfg> commit
```

Filtering Output using Pipe (|) in Show Commands

RBFS supports output filtering according to the criteria specified by the options using pipe (|) for all show commands.



Only a single-level pipe with option is supported.

- The pipe (|) command is supported only with show commands.
- The supported two options are: grep and count.

Syntax:

- <show command> | grep <search pattern>
- <show command> | count

Example:

```
supervisor@rtbrick.net: op> show version
UUID        : 4a2b63df-305b-4d15-8729-9cf6c57cb628
Version     : 25.1.0-g6daily.20250123075734+Bdevelopment.Cfbee306f
Role        : multiservice-edge
Platform    : q2a
Format      : lxd
Build date  : 2025-01-23 07:57:34 UTC
supervisor@rtbrick.net: op> show version | grep "Format|Role"
Role        : multiservice-edge
Format      : lxd
supervisor@rtbrick.net: op> show version | count
  <cr>
supervisor@rtbrick.net: op> show version | count
6
```

Error Path Information in RESTCONF Configurations

You can see the error path information, which indicates the exact hierarchy of the problematic node within a module in the RESTCONF configurations. It enables

troubleshooting easier by providing references to the interface, peer group, instance, or configuration that is causing the problem.

Example:

```
supervisor@testFix>srv02-tst.r1.nbg.rtbrick.net: cfg> show config set time-series
supervisor@testFix>srv02-tst.r1.nbg.rtbrick.net: cfg> set time-series metric test
supervisor@testFix>srv02-tst.r1.nbg.rtbrick.net: cfg> show diff set
+set time-series metric test
supervisor@testFix>srv02-tst.r1.nbg.rtbrick.net: cfg> commit
[lime]Jan 27 10:07:19: Commit failed. Edit and try again or discard changes: application missing-element
Mandatory variable 'table-name' missing for node 'metric' with path: time-series/metric/ <bad-element>table-
name</bad-element>
```

Supported Platforms

Not all features are necessarily supported on each hardware platform. Refer to the *Platform Guide* for the features and the sub-features that are or are not supported by each platform.

1.2. BDS Overview

1.2.1. BDS Overview

The Brick Data Store (BDS) is a purpose-built, in-memory state database optimized for cloud networking. In RBFS, all system state information is stored as objects in BDS tables. Objects are entries in BDS tables that represent a state.

Pub/Sub Model

All Brick Daemons (BD) independently publish and subscribe to tables in a pub/sub model. This model provides resilience and scalability. The figure illustrates the concept:

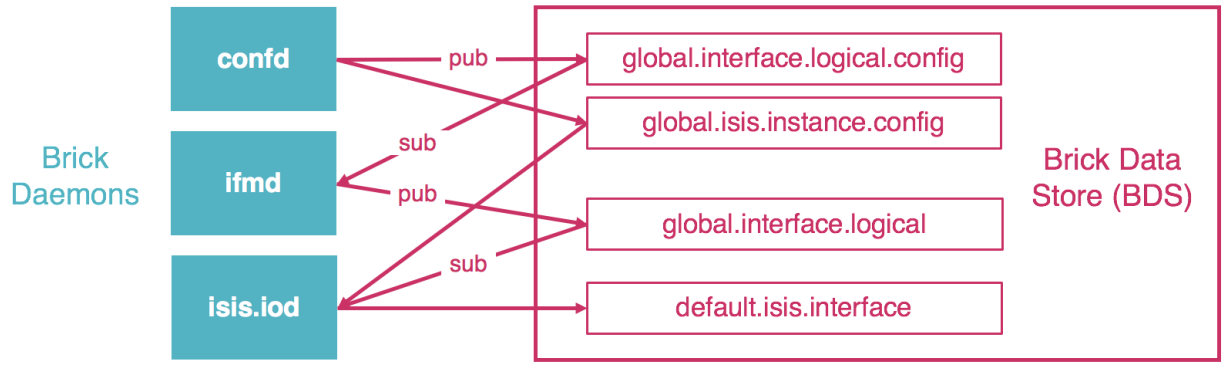


Figure 1. Pub/Sub Model

In this example, the configuration daemon (confd) publishes tables that contain configuration data for logical interfaces or IS-IS instances. The interface management daemon (ifmd) is responsible for creating and maintaining interfaces. It therefore subscribes for example to the logical interface configuration table. After processing the data, it creates the logical interfaces and publishes them in the logical interface table. The IS-IS input/output daemon (isis.iod) subscribes to the logical interface table as well as the IS-IS configuration tables. It in turn creates and runs interfaces on which IS-IS protocol packets are exchanged, and publishes them in the IS-IS interface table.

BDS User Interface

All BDS tables and objects are fully accessible to the RBS user both via CLI and an API. This provides unprecedented visibility into the system state. This guide covers the BDS CLI. For the BDS API, refer to the BDS API Reference.

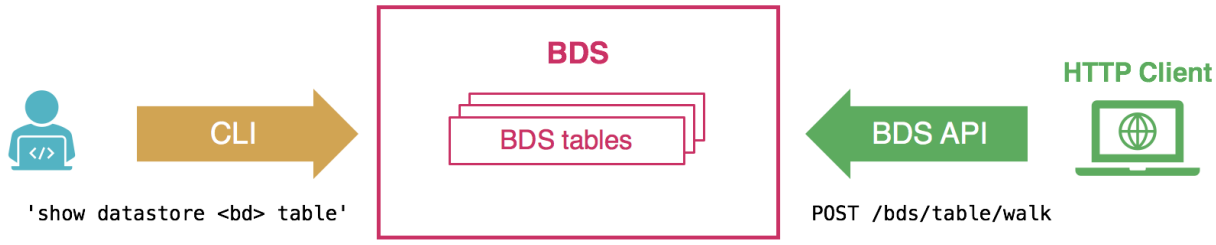


Figure 2. BDS User Interface

Please note the RBFS CLI supports show commands to verify the configuration and operation of the system for all features. Therefore you usually do not need to inspect BDS tables directly. For example, for verifying the status of the logical interfaces, you can simply use the 'show interface summary' or the 'show interface logical' commands, instead of displaying the logical interface table. The BDS CLI and API to inspect BDS tables are rather available in addition to advanced analysis or troubleshooting.

Supported Platforms

Not all features are necessarily supported on each hardware platform. Refer to the *Platform Guide* for the features and the sub-features that are or are not supported by each platform.

1.2.2. BDS Operational Commands

This section summarizes some useful BDS CLI commands. It assumes you have some basic knowledge of BDS, and are familiar with the respective tables you are looking for. Describing all tables involved in a particular feature or functionality is out of the scope of this guide.

BDS Summary

The BDS summary command provides some metadata of the BDS tables.

Syntax:

show datastore <bd-name> **summary** <option>

Option	Description
<bd-name>	Name of the brick daemon to request this information from. As all BDs independently publish and subscribe to BDS tables, they all hold a different set of tables. As a best practice, select the BD that owns the respective table you are looking for.
table <table-name>	Display metadata for the given table.

Example:

```
supervisor@rtbrick>LEAF01: op> show datastore ribd summary
Brick Datastore Summary:
Table Name: local.bds.table.registry.ribd
  Index                                          Type                 Active
Obj Memory   Index Memory
  sequence-index                                 bds_rtb_bplus           234
24.38 KB     9.59 KB
  gc-index                                       bds_rtb_bplus             0   0
bytes      0 bytes
  table-name-index                               bplus                   234
24.38 KB     9.59 KB
Table Name: local.trim.qrunner.table
  Index                                          Type                 Active
Obj Memory   Index Memory
  sequence-index                                 bds_rtb_bplus             7
840 bytes    728 bytes
  gc-index                                       bds_rtb_bplus             0   0
bytes      0 bytes
  immutable_index                                bplus                     7
840 bytes    728 bytes
```

```
  qrunner-index                                    qrunner                   7
840 bytes    728 bytes
Table Name: local.bds.statistics
  Index                                            Type                  Active
Obj Memory   Index Memory
  sequence-index                                   bds_rtb_bplus            319
34.84 KB     14.36 KB
  gc-index                                         bds_rtb_bplus              0   0
bytes      0 bytes
  immutable-index                                  bplus                    319
34.84 KB     14.36 KB
Table Name: local.bds.module.registry
  Index                                            Type                  Active
Obj Memory   Index Memory
  sequence-index                                   bds_rtb_bplus             68
3.53 KB      2.79 KB
  gc-index                                         bds_rtb_bplus              0   0
bytes      0 bytes
  module-name-index                                bplus                     68
3.53 KB      2.79 KB
<...>
```

BDS Tables

You can use the BDS table commands to display the table objects that contain the actual state information.

Syntax:

show datastore <bd-name> **table** <option>

Option	Description
<bd-name>	Name of the brick daemon to request this information from. As all BDs independently publish and subscribe to BDS tables, they all hold a different set of tables. As a best practice, select the BD that owns the respective table you are looking for.
<table-name>	Name of the BDS table to display. Without further options, this command displays all objects in a table format.
<table-name> json	Display the complete table data in JSON format.

Option	Description
<table-name> attribute <attribute-name> <attribute-value> exact	Filter the table objects based on attribute name and value. You can filter on any attribute, except for attributes of type array. The filter performs a regex match. You can therefore specify the attribute value as a regular expression (regex). You can use the exact match along with the (default) regular expression match.
<table-name> summary	Display metadata for the given table.
properties	Display owner, published/subscribed, and locality information for all tables known by the given daemon.

Example 1: Logical Interface Table

```
supervisor@rtbrick>LEAF01: op> show datastore ifmd table global.interface.logical
Object: 0, Sequence 100125, Last update: Mon Apr 03 13:49:39 GMT +0000 2023
  Attribute                                Type                             Length
Value
  logical_unit_id (1)                      uint16 (3)                            2
0
  ifl_name (2)                             string (9)                           13
ifl-0/1/31/0
  ifp_name (3)                             string (9)                           11
ifp-0/1/31
  instance (5)                             string (9)                            8
default
  mac_address (8)                          macaddr (22)                          6
e8:c5:7a:8f:76:f2
  ipv4_status (10)                         uint8 (2)                             1
up
  ipv6_status (12)                         uint8 (2)                             1
up
  mpls_mtu (13)                            uint16 (3)                            2
1500
  mpls_status (14)                         uint8 (2)                             1
up
  iso_mtu (15)                             uint16 (3)                            2
1500
  iso_status (16)                          uint8 (2)                             1
down
  admin_status (17)                        uint8 (2)                             1
up
  link_status (18)                         uint8 (2)                             1
up
  ifl_type (19)                            uint8 (2)                             1
Logical Sub interface
```

```
  operational_status (24)                  uint8 (2)                          1
up
  ifindex (25)                             uint32 (4)                         4
63745
  instance_id (27)                         uint32 (4)                         4
0
<...>
```

Example 2: Filter IPv6 Route Table by Prefix

```
supervisor@rtbrick>LEAF01: op> show datastore ribd table default.ribd.1.fib-
local.ipv6.unicast
 attribute prefix6 2001:db8::1/128
Object: 0, Sequence 1900002, Last update: Mon Apr 03 13:49:39 GMT +0000 2023
  Attribute                                Type                           Length
Value
  prefix6 (4)                              ipv6prefix (16)                   17
2001:db8::1/128
  source (11)                              uint8 (2)                          1
direct
  sub_src (12)                             uint8 (2)                          1
Host
  nexthop_key (25)                         payload (8)                       24
3c86eaebe6617cf61ed96c819cfd63839bd90cc85a533067
  preference (40)                          uint32 (4)                         4
0
  bcm_status (52)                          uint8 (2)                          1
None
  return_code (53)                         uint32 (4)                         4
0
  vpp_status (54)                          uint8 (2)                          1
None
  route_status (55)                        uint32 (4)                         4
|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-
```

Example 3: Filter IPv6 Route Table with Exact Match

```
supervisor@rtbrick>LEAF01: op> show datastore bgp.appd.1 table vrf1.bgp.rib-
in.ipv4.unicast.198.51.100.30.198.51.100.25 attribute prefix4 198.51.100.11/24
exact
Object: 0, Sequence: 367772, Last update: Wed May 19 08:05:08 GMT +0000 2021
  Attribute                                Type                           Length
Value
  status (1)                               uint8 (2)                          1
Valid
  recv_path_id (2)                         uint32 (4)                         4
0
  prefix4 (3)                              ipv4prefix (13)                    5
198.51.100.40/24
  rd (5)                                   route-distinguisher (40)           8
198.51.100.100:65001
  source (6)                               uint8 (2)                          1
bgp
  sub_src (7)                              uint8 (2)                          1
Local-Peer
  as_path (9)                              array (7), uint32 (4)             20
```

```
[57381, 42708, 1299, 5511, 3215]
  origin (10)                             uint8 (2)                          1
IGP
  peer_type (12)                          uint8 (2)                          1
2
  igp_metric (13)                         uint32 (4)                         4
4294967295
  send_path_id (18)                       uint32 (4)                         4
3238151775
  bgp_nh4 (19)                            ipv4addr (12)                      4
198.51.100.30
  community (24)                          array (7), community (27)          8
['1299:20000', '42708:200']
```

BDS Schema

The Brick Data Store is schema-driven. Table and object schema definitions are located in RBFS in /usr/share/rtbrick/libbds/. Instead of inspecting schema files, you can use the BDS schema commands to view the schemata directly in the CLI.

Syntax:

show datastore <bd-name> **schema** <option>

Option	Description
<bd-name>	Name of the brick daemon to request this information from. As all BDs independently publish and subscribe to BDS tables, they all hold a different set of tables. To view a table or object schema, you can select any BDs that know the respective table.
table-name <table-name>	Display the schema of the given table.
object object-name <object-name>	Display the schema of the given object.
object table-name <table-name>	Display the schema of the object for a given table. This option is useful if you do not know the name of the object but the name of the table in which it is used.

BDS Statistics Memory

The BDS statistics memory command provides detailed memory usage information.

Syntax:

```
show datastore <bd-name> statistics memory
```

Option	Description
<bd-name>	Name of the brick daemon of which to display the memory usage information.

2. Routing

2.1. RIB

2.1.1. RIB Overview

A Routing Information Base (RIB) stores and maintains the route information. The RIB table contains information about each reachable network prefix and the next hop information. Each routing protocol inserts its routes into the RIB when it learns a new route. The RBFS route manager (ribd) selects the best routes from the protocol RIBs and places them into the Forwarding Information Base (FIB) table. If a destination becomes unreachable, the route is marked unusable and eventually removed from the RIB

The main differences between RIB and FIB are:

- RIB is about storing and maintaining route information, including attributes for route selection (control plane), etc.
- FIB is used to determine how packets are forwarded (data plane), i.e., only contains a subset of information from RIB. Also, FIB is downloaded to ASIC or VPP.

The image below shows how various routing protocols insert their routes into the RIB.

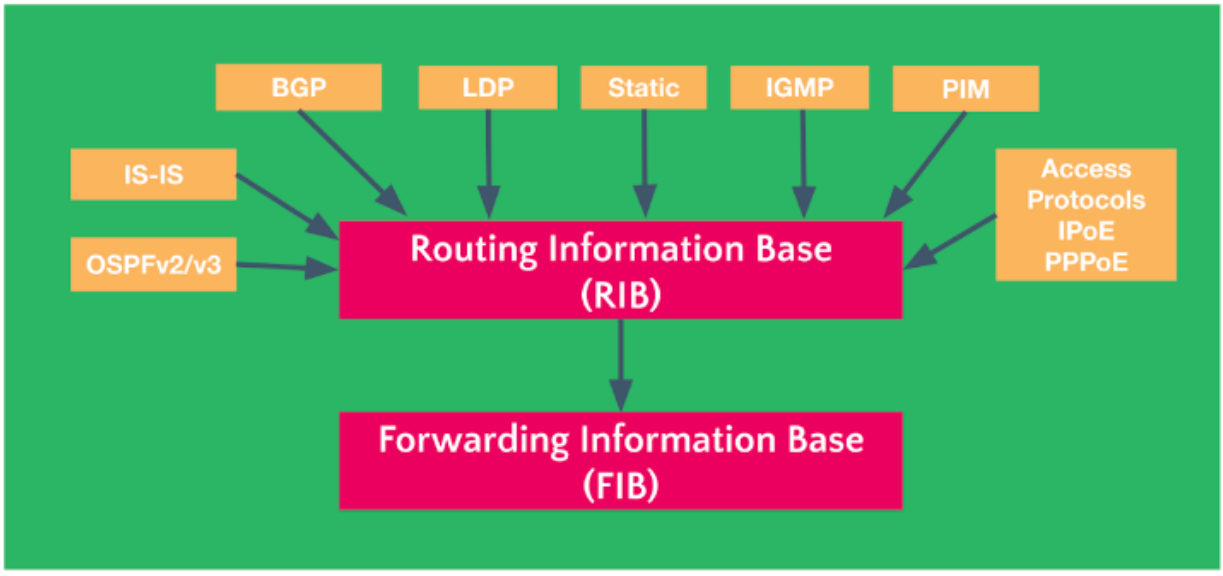


Figure 3. RIB Overview

Routing Instances

A routing instance represents a set of interfaces, routing protocols, and corresponding routing tables. You can think of a routing instance as a virtual router within RBFS.

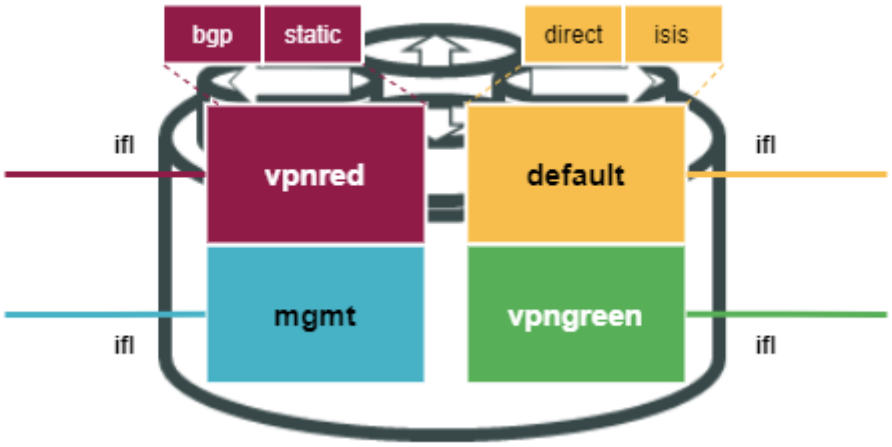


Figure 4. Routing Instances

Each logical interface (ifl) is associated uniquely with a routing instance. If no routing instance is explicitly configured, the default routing instance is used. The interface association can be seen with the show interface address command.

Routing instances are configured using the set instance <instance_name> syntax. When configuring a routing instance, you must specify which address families (AFI, SAF) the routing instance should support.

Route Preference

Several routing protocols, including static routes, may provide multiple paths to reach a particular destination. However, not all of these paths are necessarily optimal. At any given time, only one routing protocol can identify the most optimal route to the destination. Each routing protocol, including static routes, is given a preference value, where lower values indicate higher preference. In cases where multiple routing sources are present, the route identified by the routing protocol with the highest preference is selected as the best option and added to the local routing table.

Routing Protocol	Route Preference
Direct	0
Static	2

Routing Protocol	Route Preference
IPoE	7
PPP	8
LDP	9
OSPF	10
IS-IS LEVEL 1	15
IS-IS LEVEL 2	18
eBGP	20
iBGP	200

Route Prioritization

Routes are categorized into high and low priority for resolution and installation.

- **High Priority Routes include:**

  Direct

  ARP/ND

  IGP /32 or /128 Unicast

  Labeled Unicast /32 or /128

All Other Routes are considered as low priority routes.

High priority routes are processed before all other low priority routes during route resolution and installation.

Route Selection

RIBD obtains routes and corresponding next-hops from various sources such as static, protocols, and direct connections. Route selection and resolution are also handled by RIBD, which chooses the best route based on the preference assigned to each source. If multiple sources provide the same prefix, RIBD will select the best route based on the source's preference and install it in FIBD.

Route Resolution

Route resolution is the process of finding the forwarding next hop from protocol

nexthop downloaded into RIBD. For this purpose RIBD performs recursive route lookups till it finds a direct outgoing interface for the route.

For example, BGP installs a route with nexthop set to its peer IP address. However, it doesn't provide the outgoing interface. So, RIBD will check the peer IP address (next-hop IP) in its routing table (most probably downloaded by IGPs) and find the directly connected router's IP address and its outgoing nexthop.

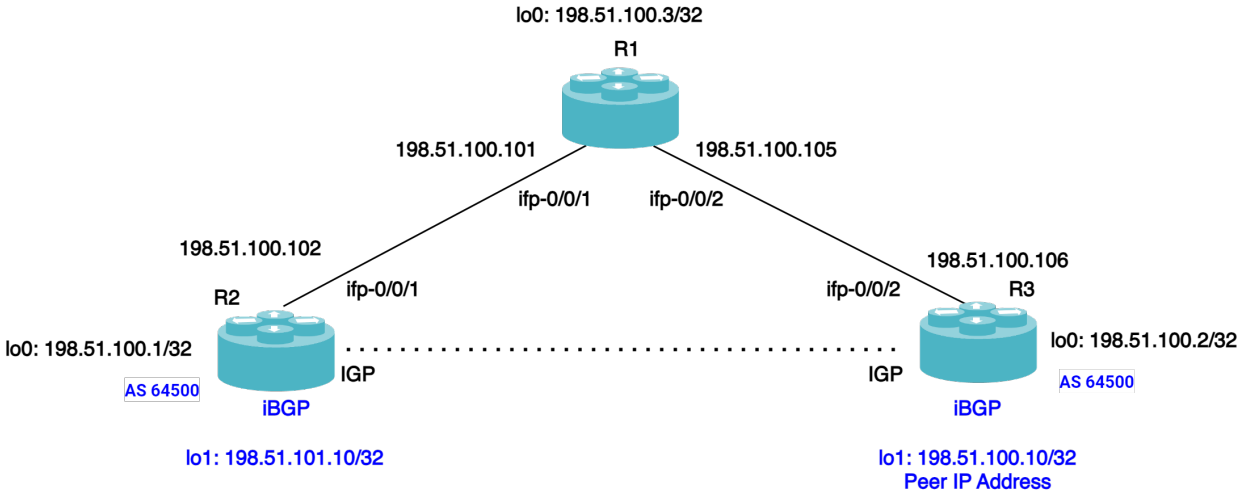


Figure 5. RIB Route Resolution

The BGP route for 198.51.100.10/32 will only be added to the routing table of router R2 if the IP address listed as the next-hop attribute is already reachable based on the information stored in the routing table. Additionally, the BGP route that is installed will contain a reference to the next-hop address 198.51.100.2 (refer to the figure above).

The network 198.51.100.10/32 can be accessed through an IP address that is not directly connected. The physical interface is not located where the BGP route is installed, so it is added to the IP routing table without any information about the outgoing interface. To find the BGP next-hop in the routing table, the router must perform a recursive lookup. However, to use a BGP route, the BGP next-hop IP address must be reachable. This is usually done through an IGP that provides reachability information. In this case, the BGP next-hop 198.51.100.2 is found in the routing table of R2, which is known via OSPF. The outgoing interface is ifp-0/0/1.

During the first route lookup, the router checks whether the destination prefix is in the routing table. If it is, then a recursive lookup is performed for the next-hop IP address. Since the next hop address is not a directly connected interface, the router needs to do a recursive lookup to find it.

Below is an example of the BGP route resolution for prefix:198.51.100.10/32:

```
supervisor@rtbrick.net: op> show route-resolution resolved prefix 198.51.100.10
198.51.100.10, Source: bgp
  Destination instance: default, AFI: ipv4, SAFI: unicast
  Lookup      instance: default, AFI: ipv4, SAFI: unicast
  Covering Prefix: 198.51.100.10
    Interface        MAC Address         Nexthop
    ifl-0/0/1/13    e8:c5:7a:8f:56:47    198.51.100.101
```

Policy Attachments

Routing Policies are a set of rules that enable you to manage and alter the default behavior of routing protocols, like BGP and IS-IS. Such policies consist of various "terms," which include "match" and "action" sections with control. The traffic that matches the "match" block is handled by the "action" block.

Once policies have been created, they need to be applied to take effect. Attachment points describe the specific applications and processes to which policies can be applied.

For more information, see section “2.2.4. Attaching Policies” of the Policy User Guide.

Nexthops

Nexthop helps routers determine the best path for forwarding data packets to their final destination efficiently. The next hop is identified by its IP address, which is stored in the routing table alongside the associated network prefix and other routing information.

Adjacency

The FIB learns the routing information from the routing table and tracks the next hop for all routes. The adjacency table maintains Layer 2 information(Nexthop) for the routes listed in the FIB (the resolved routes that can be installed into the hardware).

FIB

FIB determines how packets are forwarded (data plane), i.e., it only contains a subset of information from RIB. Also, FIB is downloaded to ASIC or VPP.

The main difference between the RIB and the FIB is that the RIB contains all the routes the router has learned, while the FIB only contains the best paths to each destination network. The RIB is constantly updated by the routing protocols and static configuration, while the FIB is only updated when the router needs to recalculate the best paths. The FIB is also updated more quickly than the RIB since it only needs to store the best paths and not all routes. The FIB maintains next-hop address information based on the information in the IP routing table.

ECMP Hashing Algorithm

The ECMP hashing algorithm distributes traffic across multiple paths or links for load balancing. It achieves this by using various packet header fields (like IP addresses, port numbers, or MAC addresses) to generate a hash value, ensuring probability and an equitable distribution of network traffic.

The following table lists the packet header fields that are used by the ECMP hashing algorithm to generate a hash value, which in turn determines how traffic is distributed. A tick ( ) indicates that the field is used by the hashing algorithm. A cross mark ( ) indicates that the field is not used by the hashing algorithm.

IPv4 UDP/TCP

The following table lists the header fields used in the ECMP hashing algorithm for different platforms when handling IPv4 UDP/TCP traffic.

Header Field	UfiSpace S9600-102XC	UfiSpace S9600-72XC	UfiSpace S9600-32X	UfiSpace S9510-28DC	UfiSpace S9500-22XST	Edgecore AGR420	Edgecore AGR400	Edgecore CSR440
Source IP Address (SIP)								
Destination IP Address (DIP)								
Protocol								
Source Port								
Destination Port								

IPv4

The following table lists the header fields used in the ECMP hashing algorithm for different platforms when handling IPv4 traffic.

Header Field	UfiSpace S9600-102XC	UfiSpace S9600-72XC	UfiSpace S9600-32X	UfiSpace S9510-28DC	UfiSpace S9500-22XST	Edgecore AGR420	Edgecore AGR400	Edgecore CSR440
Source IP Address (SIP)								
Destination IP Address (DIP)								
Protocol								

IPv6 UDP/TCP

The following table lists the header fields used in the ECMP hashing algorithm for different platforms when handling IPv6 UDP/TCP traffic.

Header Field	UfiSpace S9600-102XC	UfiSpace S9600-72XC	UfiSpace S9600-32X	UfiSpace S9510-28DC	UfiSpace S9500-22XST	Edgecore AGR420	Edgecore AGR400	Edgecore CSR440
Source IP Address (SIP)								
Destination IP Address (DIP)								
Next Header								
Source Port								
Destination Port								
Flow Label (FL)								

IPv6

The following table lists the header fields used in the ECMP hashing algorithm for

different platforms when handling IPv6 traffic.

Header Field	UfiSpace S9600-102XC	UfiSpace S9600-72XC	UfiSpace S9600-32X	UfiSpace S9510-28DC	UfiSpace S9500-22XST	Edgecore AGR420	Edgecore AGR400	Edgecore CSR440
Source IP Address (SIP)								
Destination IP Address (DIP)								
Next Header								
Flow Label (FL)								

Ethernet (L2 Forwarding)

The following table lists the header fields used in the ECMP hashing algorithm for different platforms when handling Ethernet (L2 Forwarding) traffic.

Header Field	UfiSpace S9600-102XC	UfiSpace S9600-72XC	UfiSpace S9600-32X	UfiSpace S9510-28DC	UfiSpace S9500-22XST	Edgecore AGR420	Edgecore AGR400	Edgecore CSR440
Source MAC								
Destination MAC								
EtherType								
VLAN								

MPLS

The following table lists the header fields used in the ECMP hashing algorithm for different platforms when handling MPLS traffic.

Header Field	UfiSpace S9600-102XC	UfiSpace S9600-72XC	UfiSpace S9600-32X	UfiSpace S9510-28DC	UfiSpace S9500-22XST	Edgecore AGR420	Edgecore AGR400	Edgecore CSR440
All MPLS Labels								

Field Definitions

SIP/DIP (Source/Destination IP Address)

Identifies the source/destination of the packet, that is, IPv4/IPv6

Next Header/Protocol

Identifies the type of payload, such as TCP, UDP etc.

L4 Ports (Source/Destination Port)

Used in TCP/UDP headers to identify application endpoints

FL (Flow Label)

Used for IPv6 to improve load balancing

MAC Addresses (Source/Destination MAC)

Used in Ethernet frames for identifying source and destination devices

EtherType

Indicates the protocol encapsulated in the Ethernet frame

VLAN

Identifies the VLAN to which the frame belongs

MPLS Labels

Used in MPLS networks to identify the destination / Forward Equivalence Class for packet forwarding

2.1.2. RIB Operational commands

Display Routes

The show route command displays information on routes.

Syntax:

```
show route <option>
```

Option	Description
-	Without any option, the command shows the information for all routes for all instances.
detail	Shows detailed route information.
import	The commands show all the routes imported from another instance. For information about route import command options, see section Show Route Import.
incoming interface <name>	Shows the information of the specified interface through which the routes enter to the router.
instance <name>	Shows routing table information for a specified instance.
hierarchy	Shows routing information in a hierarchical
ipv4	Shows route information for the IPv4 routing table.
ipv6	Shows route information for the IPv6 routing table.
l2vpn	Shows route information for the L2VPN routing table. For information about l2vpn command options, see section Show Route L2VPN.
mpls	Shows route information for the MPLS routing table.
prefix <value>	Shows route information for a specified destination prefix.
prefix-length-distribution	Shows the number of routes with the same prefix length for the sources.
service	Shows the number of routes with the same service label.
source	Shows routes from a specified source.
summary	Shows the number of routes selected by RIB for each source.

Example 1: The following example shows route information.

```
supervisor@rtbrick>LEAF01: op> show route
Instance: default, AFI: ipv4, SAFI: unicast
Prefix/Label                            Source           Pref    Next Hop
Interface
192.1.0.3/32                            direct           0       192.1.0.3
lo-0/0/0/1

Instance: default, AFI: ipv4, SAFI: labeled-unicast
Prefix/Label                            Source           Pref    Next Hop
Interface                     Label
192.1.0.3/32                            direct           0       192.1.0.3
lo-0/0/0/1                    -
Instance: default, AFI: ipv6, SAFI: unicast
Prefix/Label                            Source           Pref    Next Hop
Interface

192:1::2/128                            bgp              20      fe80::eac5:7aff:fe8f:5663
ifl-0/1/70/13
192:1::3/128                            direct           0       192:1::3
lo-0/0/0/1

192:1::4/128                            bgp              20      fe80::eac5:7aff:fe8f:5663
ifl-0/1/70/13
Instance: default, AFI: ipv6, SAFI: labeled-unicast
Prefix/Label                            Source           Pref    Next Hop
Interface                     Label
192:1::2/128                            bgp              20      fe80::eac5:7aff:fe8f:5663
ifl-0/1/70/13                 -
192:1::3/128                            direct           0       192:1::3
lo-0/0/0/1                    -
192:1::4/128                            bgp              20      fe80::eac5:7aff:fe8f:5663
ifl-0/1/70/13                 2020
```

Example 2: A route summary is shown in the following example.

```
supervisor@rtbrick>LEAF01: op>  show route summary
Instance: default
  Source                  Routes
  bgp                          4
  direct                       4
  Total Routes                 8
Instance: inband-vrf
  Source                  Routes
  bgp                          4
  direct                       2
  Total Routes                 6
Instance: vrf1
  Source                  Routes
  bgp                          3
  direct                       2
  Total Routes                 5
Instance: li-vrf
  Source                  Routes
  bgp                          2
  direct                       2
  Total Routes                 4
Instance: mgmt-vrf
  Source                  Routes
  bgp                          4
  direct                       2
  Total Routes                 6
Instance: radius-vrf
  Source                  Routes
  bgp                          3
```

```
  direct                      2
  Total Routes                5
```

Example 3: This example shows routes with IPv4 prefixes of the same length

```
supervisor@rtbrick>LEAF01: op>> show route prefix-length-distribution
Instance: default
  Prefix Length      Count
            /32          2
           /128          6
            Sum          8
Instance: inband-vrf
  Prefix Length      Count
            /32          3
           /128          3
            Sum          6
Instance: vrf1
  Prefix Length      Count
            /24          1
            /32          2
           /128          2
            Sum          5
Instance: li-vrf
  Prefix Length      Count
            /32          2
           /128          2
            Sum          4
Instance: mgmt-vrf
  Prefix Length      Count
            /32          3
           /128          3
            Sum          6
Instance: radius-vrf
  Prefix Length      Count
            /24          1
            /32          2
           /128          2
            Sum          5
```

Show Route Hierarchy

The show route hierarchy command provides the complete information of a prefix at a given afi, safi, instance from its source, RIBD, and FIBD.

Syntax:

show route hierarchy <option>

Option	Description
instance <instance_name>	Name fof the instance.
<afi>	To show only the routes for a specific network protocol, such as IPv4 or IPv6.
<safi>	To view specific types of routes, such as IPv4 unicast or IPv6 multicast,received from neighbors.
<afi> <safi> detail	Shows information in detail for a specified afi or safi.
<afi> <safi> instance <instance-name>	Filter route entries for specified instance for a specifc afi and safi.
label	Filters route entries by a specific MPLS label.
prefix	Filters route entries by a specified IP prefix.

Example:

```
supervisor@rtbrick.net: cfg> show route hierarchy ipv4 unicast instance default
prefix 192.1.0.1/32
direct:
  prefix: 192.1.0.1/32
    nexthop set hash: 11de2090964a7b7176fc8add0c2c8b9cab7d22e52ff8f1a3
      nexthop hash: 16805dc42973c9ddb6289aac36994bbcb11e09ef6fbdc65b
        nexthop4: 192.1.0.1, exit interface: lo-0/0/0/10
isis:
  prefix: 192.1.0.1/32
  preference: 15
    nexthop set hash: 144ebc3d7e41a1cbf034f0c2c278a70df83d4717b1dfec6a
      nexthop hash: 45611a55482ca710251d15dd7f0bb89aba8819025e68029f
        exit interface: local
ribd:
  prefix: 192.1.0.1/32
  source: direct
    adjacency set hash: 11de2090964a7b7176fc8add0c2c8b9cab7d22e52ff8f1a3
      nexthop hash: 16805dc42973c9ddb6289aac36994bbcb11e09ef6fbdc65b
        nexthop4: 192.1.0.1, exit interface: lo-0/0/0/10
fibd:
  prefix: 192.1.0.1/32
  source: direct
  route status: |VPP Route ADD|-|-|VPP Route Mapping Failure|-|VPP Route ADJ
Failure|-|-|-|-|-|-|-|BCM Route ADD|-|-|-|-|-|-|-
  bcm status: Download success
  vpp status: None
    adjacency set hash: 11de2090964a7b7176fc8add0c2c8b9cab7d22e52ff8f1a3
      nexthop hash: 16805dc42973c9ddb6289aac36994bbcb11e09ef6fbdc65b
        exit interface: lo-0/0/0/10
```

Show Route Import

Syntax:

```
show route import <option>
```

Option	Description
import	The command shows all the routes imported from another instance.
detail	Shows detailed information for imported routes.
instance	Shows routing table information for a specific instance for imported routes.
ipv4	Shows route information for the IPv4 routing table for imported routes.
ipv6	Shows route information for the IPv4 routing table for imported routes.
source	Shows source of the routing information for the specified source.
summary	Shows the number of imported routes selected by RIB for each source.

Show Route L2VPN

Syntax:

```
show route l2vpn <option>
```

Option	Description
l2vpn	Without any option, the commands display all the L2VPN routes.
detail	Shows detailed information for l2vpn routes.
evpn-vpws	Shows routing table information for the EVPN-VPWS address family.

Option	Description
instance	Shows L2VPN routing table information for a specific instance
label <label>	Shows L2VPN routing table information for destination label.
prefix	Shows L2VPN routing table information for the destination prefix.
source	Shows source information for the L2VPN routes.
summary	Shows the number of L2VPN routes selected by RIBD for each source.
vpls-vpws	Shows the L2VPN routes from VPLS-VPWS address specified.

Show Route Resolution

The show route-resolution command displays the routes that were requested to be resolved for their nexthops. Otherwise, it shows the route is unresolved.

Syntax:

show route-resolution <options>

Option	Description
-	Without any option, the command shows the information for all requests and response tables side by side.
destination-instance	Shows the information for all requests and responses for a destination instance.
look-up instance	Shows lookup instance routes.
prefix	Shows routes for prefix 4 or prefix 6.
resolved	Shows resolved routes.
source	Shows source of requested source.
unresolved	Shows unresolved routes.

Example 1: Below is an example of the route resolution requested by the protocol BGP.

```
supervisor@rtbrick>LEAF01: op> show route-resolution
192:1::2, Source: bgp
  Destination instance: default, AFI: ipv4, SAFI: vpn-multicast
  Lookup      instance: default, AFI: ipv6, SAFI: labeled-unicast
  Covering Prefix: 192:1::2/128
    Interface        MAC Address         Nexthop
    ifl-0/1/70/13    e8:c5:7a:8f:56:63   fe80::eac5:7aff:fe8f:5663
fe80::eac5:7aff:fe8f:5663, Source: bgp
  Destination instance: default, AFI: ipv6, SAFI: unicast
  Lookup      instance: default, AFI: ipv6, SAFI: unicast
  Covering Prefix: fe80::eac5:7aff:fe8f:5663/128
    Interface        MAC Address         Nexthop
    ifl-0/1/70/13    e8:c5:7a:8f:56:63   fe80::eac5:7aff:fe8f:5663
fe80::eac5:7aff:fe8f:5663, Source: bgp
  Destination instance: default, AFI: ipv4, SAFI: vpn-unicast
  Lookup      instance: default, AFI: ipv6, SAFI: labeled-unicast
  Covering Prefix: fe80::eac5:7aff:fe8f:5663/128
    Interface        MAC Address         Nexthop
    ifl-0/1/70/13    e8:c5:7a:8f:56:63   fe80::eac5:7aff:fe8f:5663
fe80::eac5:7aff:fe8f:5663, Source: bgp
  Destination instance: default, AFI: ipv6, SAFI: labeled-unicast
  Lookup      instance: default, AFI: ipv6, SAFI: labeled-unicast
  Covering Prefix: fe80::eac5:7aff:fe8f:5663/128
    Interface        MAC Address         Nexthop
    ifl-0/1/70/13    e8:c5:7a:8f:56:63   fe80::eac5:7aff:fe8f:5663
fe80::eac5:7aff:fe8f:5663, Source: bgp
  Destination instance: default, AFI: ipv6, SAFI: vpn-unicast
  Lookup      instance: default, AFI: ipv6, SAFI: labeled-unicast
  Covering Prefix: fe80::eac5:7aff:fe8f:5663/128
    Interface        MAC Address         Nexthop
    ifl-0/1/70/13    e8:c5:7a:8f:56:63   fe80::eac5:7aff:fe8f:5663
```

Example 2: Below is an example of the unresolved route resolution.

```
supervisor@rtbrick>ufi07.q2c.u21.r4.nbg.rtbrick.net: cfg> show route-resolution unresolved
192.168.16.128, Source: radius
  Lookup      instance: inband_mgmt, AFI: ipv4, SAFI: unicast
  Covering Prefix: None, 7 resolution attempts
198.18.73.251, Source: pim
  Lookup      instance: ip2, AFI: ipv4, SAFI: unicast
  Covering Prefix: None, 7 resolution attempts
```

Show Route rib-in

The show route rib-in command shows all advertised routes' information received and stored in the inbound RIB (Routing Information Base). These commands allow you to view routes based on specific criteria such as instance, source, address family (AFI), subsequent address family identifier (SAFI) and so on.

Syntax:

```
show route rib-in <options>
```

Option	Description
-	Without any option, the command shows the information for all routes in the routing information base.
detail	Provides a detailed view of routes matching the specified prefix in the inbound RIB.
<afi>	To show only the routes for a specific network protocol, such as IPv4 or IPv6.
<safi>	To view specific types of routes, such as IPv4 unicast or IPv6 multicast, received from neighbors.
instance <instance>	Shows the routes in the inbound RIB of a specific routing instance.
source <source>	Shows the routes in the inbound RIB from a specific neighbor.
summary	Provides a summary view of all routes in the inbound RIB.

Show Route Prefix

The show route prefix command shows all advertised routes' information received and stored in the inbound RIB (Routing Information Base).

Syntax:

```
show route prefix <options>
```

Option	Description
-	Without any option, the command shows the information for all routes in the routing information base.

Option	Description
prefix <value>	Specify the prefix. This is to see if a specific route with a particular prefix has been received from a neighbor.
rib-in	Shows all routes currently stored in the routing information base without any filtering.
detail	Provides a detailed view of routes matching the specified prefix in the inbound RIB.

2.2. Route Leaking

2.2.1. Route Leaking Overview

Route leaking involves exporting a route from one routing instance to another routing instance.

As shown in the figure below, RBFS allows importing routes from the RIB of one instance to another instance. Additionally, the routes can be selectively imported based on the associated policy.

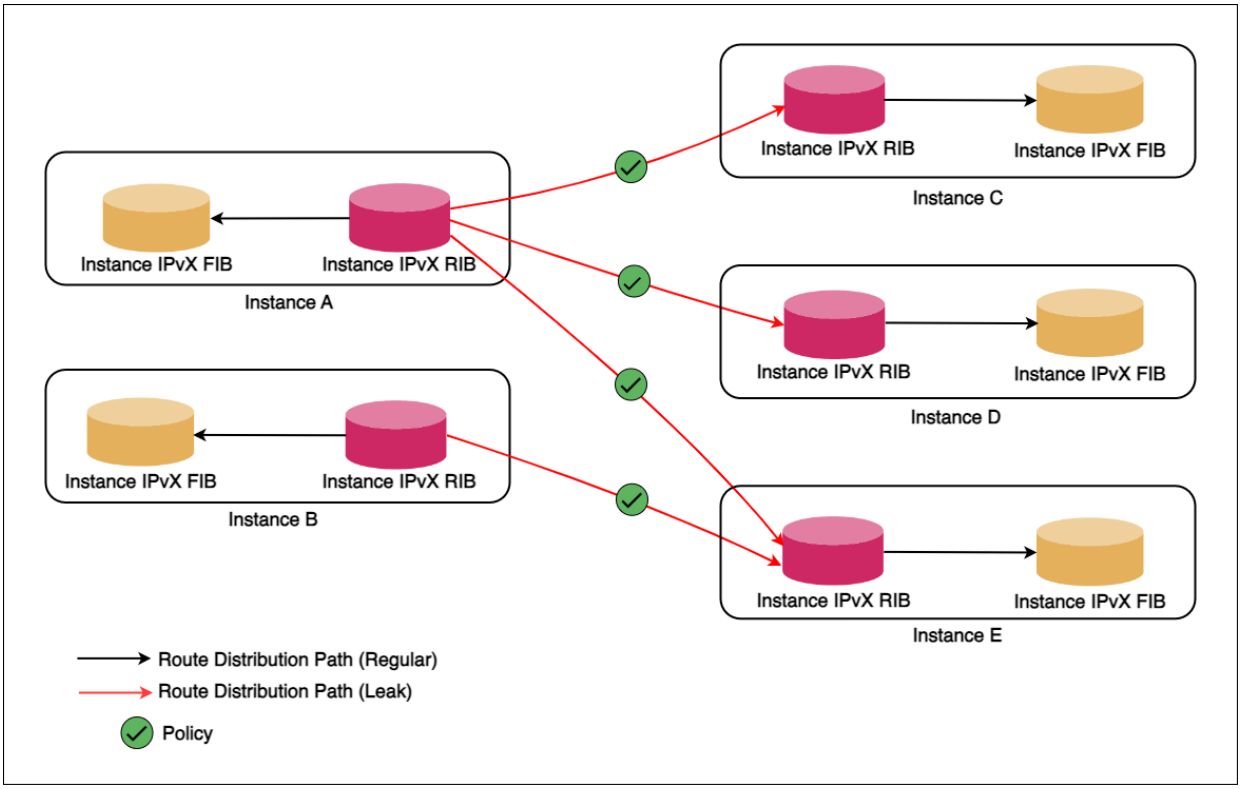


Figure 6. Route Leaking Across Instances

Guidelines and Limitations

- Currently, the route leaking “import-rib” feature is limited to importing only IPv4 and IPv6 unicast routes.

Supported Platforms

The Route Leaking feature is supported by the Multiservice Edge images for the following Q2A and Q2C hardware platforms.

Q2A:

- Edgecore CSR440 (AS7535-28XB)
- UfiSpace S9510-28DC

Q2C:

- Edgecore AGR420 (AS7946-74XKSB)
- UfiSpace S9600-72XC
- UfiSpace S9600-102XC

Route Leaking Policy Attributes and Match Types

The following table provides all the supported route leaking policy attributes and match types.

Attribute Type	Match Types Supported
ipv4-prefix	regex exact longer or-longer prefix-length-exact prefix-length-greater prefix-length-greater-or-exact

Attribute Type	Match Types Supported
ipv6-prefix	regex exact longer or-longer prefix-length-exact prefix-length-greater prefix-length-greater-or-exact
community	regex exact exists
extended-community	regex exact exists
large-community	regex exact exists
source	regex exact

2.2.2. Route Leaking Configuration

Configuring Route Leaking from one instance to another

To configure route leaking from one instance to another, configure the "import-rib" for the routing instance (AFI/SAFI).

Syntax:

set instance <destination-instance> **address-family** <afi> <safi> **import-rib** <source-instance>

Attribute	Value
<destination-instance>	Name of the routing instance to which routes will be imported to.

Attribute	Value
<afi>	Address family identifier (AFI). Supported values: ipv4, ipv6.
<safi>	Subsequent address family identifier (SAFI). Supported values: unicast.
<source-instance>	Specifies the routing instance from which the routes will be imported.

In the following example, IPv4 and IPv6 unicast routes will be copied from the “vrf-blue” to “vrf-red” instance RIB.

```
set instance vrf-red address-family ipv4 unicast import-rib vrf-blue
set instance vrf-red address-family ipv6 unicast import-rib vrf-blue
```

The following is an example of JSON output showing the instance configuration.

```
supervisor@rtbrick>LEAF01: cfg> show config instance vrf-red
{
  "rtbrick-config:instance": [
    {
      "name": "vrf-red",
      "address-family": [
        {
          "afi": "ipv4",
          "safi": "unicast",
          "import-rib": [
            {
              "instance": "vrf-blue"
            }
          ]
        },
        {
          "afi": "ipv6",
          "safi": "unicast",
          "import-rib": [
            {
              "instance": "vrf-blue"
            }
          ]
        }
      ]
    }
  ]
}
```

Configuring Route Leaking with Policy

You can attach a policy to import selective routes as per the required criteria.

Syntax:

set instance <destination-instance> **address-family** <afi> <safi> **import-rib** <source-instance> **policy** <policy-name>

Attribute	Value
<destination-instance>	Name of the routing instance to which routes will be imported to.
<afi>	Address family identifier (AFI). Supported values: ipv4, ipv6.
<safi>	Subsequent address family identifier (SAFI). Supported values: unicast.
<source-instance>	Name of the routing instance to which routes will be imported.
<policy-name>	Name of the routing instance to which routes will be imported based on the specified policy.

In the following example, the policy match_ipv4_prefix is attached to the 'vrf-blue' instance.

```
set instance vrf-red address-family ipv4 unicast import-rib vrf-blue policy
match_ipv4_prefix
```

Example: The following is an example of JSON output of the above configuration.

```
{
  "rtbrick-config:instance": [
    {
      "name": "vrf-red",
      "address-family": [
        {
          "afi": "ipv4",
          "safi": "unicast",
          "import-rib": [
            {
              "instance": "vrf-blue",
              "policy": "match_ipv4_prefix"
            }
          ]
        }
      ]
    }
  ]
```

```
}
```

2.2.3. Route Leaking Operational Commands

show route import

The show route import command displays all the imported routes.

Syntax:

show route import <option>

Attribute	Value
detail	Displays detailed route information of the imported routes.
instance <instance-name>	Displays route information for the imported routes for the specified instance.
instance <instance-name> detail	Displays detailed route information for the imported routes for the specified instance.
instances <instance-name> prefix <prefix>	Displays route information for the imported routes for the specified instance and prefix.
instance <instance-name> prefix <prefix> detail	Displays detailed route information for the imported routes for the specified instance and prefix.
instance <instance-name> summary	Displays summarized route information for the imported routes for the specified instance.
ipv4	Displays route information for the IPv4 address family.
ipv6	Displays route information for the IPv6 address family.
source	Displays route information for the specified route source.
summary	Display summarized route information for the imported routes.

Example 1: Source instance (vrf-blue) RIB

```
supervisor@rtbrick>LEAF01: op> show route ipv4 unicast source bgp instance vrf-
```

```
blue
Flags: & - Imported
Instance: vrf-blue, AFI: ipv4, SAFI: unicast
Flags  Prefix/Label       Source        Pref    Next Hop     Outgoing Interface
       192.168.0.20/32    bgp           20      12.0.0.2     ifl-0/0/2/0
       192.168.0.21/32    bgp           20      12.0.0.2     ifl-0/0/2/0
       192.168.1.20/32    bgp           20      12.0.0.2     ifl-0/0/2/0
       192.168.1.21/32    bgp           20      12.0.0.2     ifl-0/0/2/0
       192.168.4.20/32    bgp           20      12.0.0.2     ifl-0/0/2/0
```

Example 2: Destination instance RIB

```
supervisor@rtbrick>LEAF01: op> show route import ipv4 unicast source bgp instance
vrf-red
Flags: & - Imported
Instance: vrf-red, AFI: ipv4, SAFI: unicast
Flags  Prefix/Label     Source   Pref    Next Hop     Outgoing Interface
&      192.168.0.20/32  bgp      20      12.0.0.2     ifl-0/0/2/0
&      192.168.0.21/32  bgp      20      12.0.0.2     ifl-0/0/2/0
&      192.168.1.20/32  bgp      20      12.0.0.2     ifl-0/0/2/0
&      192.168.1.21/32  bgp      20      12.0.0.2     ifl-0/0/2/0
&      192.168.4.20/32  bgp      20      12.0.0.2     ifl-0/0/2/0
```

Example 3: Detailed view of the destination instance (vrf-red) RIB

```
supervisor@rtbrick>LEAF01: op> show route import ipv4 unicast source bgp instance
vrf-red detail
Instance: vrf-red, AFI: ipv4, SAFI: unicast
192.168.0.20/32
  Source: bgp, Preference: 20
  Import type: inter-instance, Import instance: vrf-blue
    Next Hop: 12.0.0.2
      Covering prefix: 12.0.0.2/32
      Next Hop type: direct, Next Hop action: None
      Resolved in: default-ipv4-labeled-unicast
      Outgoing Interface: ifl-0/0/2/0, NextHop MAC: 7a:02:bb:c0:00:00
192.168.0.21/32
  Source: bgp, Preference: 20
  Import type: inter-instance, Import instance: vrf-blue
    Next Hop: 12.0.0.2
      Covering prefix: 12.0.0.2/32
      Next Hop type: direct, Next Hop action: None
      Resolved in: default-ipv4-labeled-unicast
      Outgoing Interface: ifl-0/0/2/0, NextHop MAC: 7a:02:bb:c0:00:00
192.168.1.20/32
  Source: bgp, Preference: 20
  Import type: inter-instance, Import instance: vrf-blue
    Next Hop: 12.0.0.2
      Covering prefix: 12.0.0.2/32
      Next Hop type: direct, Next Hop action: None
      Resolved in: default-ipv4-labeled-unicast
      Outgoing Interface: ifl-0/0/2/0, NextHop MAC: 7a:02:bb:c0:00:00
192.168.1.21/32
  Source: bgp, Preference: 20
  Import type: inter-instance, Import instance: vrf-blue
    Next Hop: 12.0.0.2
```

```
      Covering prefix: 12.0.0.2/32
      Next Hop type: direct, Next Hop action: None
      Resolved in: default-ipv4-labeled-unicast
      Outgoing Interface: ifl-0/0/2/0, NextHop MAC: 7a:02:bb:c0:00:00
192.168.4.20/32
  Source: bgp, Preference: 20
  Import type: inter-instance, Import instance: vrf-blue
    Next Hop: 12.0.0.2
      Covering prefix: 12.0.0.2/32
      Next Hop type: direct, Next Hop action: None
      Resolved in: default-ipv4-labeled-unicast
      Outgoing Interface: ifl-0/0/2/0, NextHop MAC: 7a:02:bb:c0:00:00
```

Example 4: Destination instance (vrf-red) RIB after applying the policy (match_ipv4_prefix)

```
supervisor@rtbrick>LEAF01: op> show route import ipv4 unicast source bgp instance
vrf-red
Flags: & - Imported
Instance: vrf-red, AFI: ipv4, SAFI: unicast
Flags  Prefix/Label      Source     Pref    Next Hop  Outgoing Interface
&      192.168.1.20/32   bgp        20      12.0.0.2  ifl-0/0/2/0
```

In the above example, the below policy is used to import the selective route.

```
set policy statement match_ipv4_prefix
set policy statement match_ipv4_prefix ordinal 1
set policy statement match_ipv4_prefix ordinal 1 match
set policy statement match_ipv4_prefix ordinal 1 match rule 1
set policy statement match_ipv4_prefix ordinal 1 match rule 1 type ipv4-prefix
set policy statement match_ipv4_prefix ordinal 1 match rule 1 value-type discrete
set policy statement match_ipv4_prefix ordinal 1 match rule 1 match-type exact
set policy statement match_ipv4_prefix ordinal 1 match rule 1 value
192.168.1.20/32
set policy statement match_ipv4_prefix ordinal 1 action
set policy statement match_ipv4_prefix ordinal 1 action rule 1
set policy statement match_ipv4_prefix ordinal 1 action rule 1 operation return-
permit
```

The following is an example of JSON output showing the above policy configuration.

```
{
  "rtbrick-config:statement": [
    {
      "name": "match_ipv4_prefix",
      "ordinal": [
        {
          "ordinal": 1,
          "match": {
            "rule": [
              {
```

```
                "rule": 1,
                "type": "ipv4-prefix",
                "value-type": "discrete",
                "match-type": "exact",
                "value": [
                  "192.168.1.20/32"
                  ]
              }
            ]
          },
          "action": {
            "rule": [
              {
                "rule": 1,
                "operation": "return-permit"
              }
            ]
          }
        }
      ]
    }
  ]
}
```

2.3. BGP

2.3.1. BGP Overview

BGP is a standard exterior gateway protocol (EGP) supported by RtBrick. BGP is considered a “Path Vector” routing protocol and maintains a separate routing table based on the shortest Autonomous System (AS) path and various other route attributes.

Supported BGP Standards

RFC Number	Description
RFC 2545	Use of BGP-4 Multiprotocol Extensions for IPv6 Inter-Domain Routing
RFC 2918	Route Refresh Capability for BGP-4
RFC 4271	A Border Gateway Protocol 4 (BGP-4)
RFC 4364	BGP/MPLS IP Virtual Private Networks (VPNs)
RFC 4456	BGP Route Reflection: An Alternative to Full Mesh Internal BGP (IBGP)
RFC 4486	Subcodes for BGP Cease Notification Message

RFC Number	Description
RFC 4760	Multiprotocol Extensions for BGP-4
RFC 5492	Capabilities Advertisement with BGP-4
RFC 6793	BGP Support for Four-Octet Autonomous System (AS) Number Space
RFC 6608	Subcodes for BGP Finite State Machine Error
RFC 6774	Distribution of Diverse BGP Paths [Partial Support]



RFC and draft compliance are partial except as specified.

Supported Platforms

Not all features are necessarily supported on each hardware platform. Refer to the *Platform Guide* for the features and the sub-features that are or are not supported by each platform.

Supported BGP Features

The RBFS supports the following BGP functions:

- Basic BGP Protocol
- Multiprotocol extension for BGP
- Multipath for iBGP and eBGP
- Four-byte AS numbers
- Nexthop Self or next-hop unchanged
- Fast external-failover
- Route reflection
- MD5 Authentication
- Generalized TTL Security Mechanism (GTSM)
- Route Refresh
- Advanced route refresh
- Route redistribution
- Multihop EBGP

- Route selection flexibility (always compare MED, ignore AS Path, and so on)
- Add path
- Hostname/Domain name
- Dynamic peers
- Community, Extended Community, and Large Community support
- 6PE Support
- Curated Upstream Path Selection

The statements and commands required to configure and verify the functioning of BGP features are described in this guide.

MD5 Authentication

BGP supports the authentication mechanism using the Message Digest 5 (MD5) algorithm. When authentication is enabled, any Transmission Control Protocol (TCP) segment belonging to BGP exchanged between the peers is verified and accepted only if authentication is successful. For authentication to be successful, both peers must be configured with the same password. If authentication fails, the BGP neighbor relationship is not established.

GTSM

The Generalized TTL Security Mechanism (GTSM) protects a BGP session by evaluating the Time to Live (TTL) value contained in the IP header of incoming BGP packets.

TTL security is enabled using the ttl-security command on a single-hop BGP session. When TTL security is enabled on a BGP session the IP TTL values in packets is set to 255. To enable TTL security on a multihop BGP session, enable ttl-security and configure ttl-limit to match the expected TTL value.

For details about configuring GTSM, see the Peer Group Configuration section.

IPv6 Provider Edge (6PE)

The Provider Edge (6PE) solution enables IPv6 communication over the MPLS IPv4 core network. IPv6 reachability information is associated with a label and transferred through MP-BGP(AFI: 2 SAFI:4). IPv4 mapped IPv6 address is used to

encode the next-hop information. The edge nodes in the MPLS IPv4 core have to support both IPv4 and IPv6. The IPv6 Labeled Unicast routes received from the 6PE peer is considered as IPv6 unicast routes and installed in IPv6 Unicast FIB. The received Label is attached to the IPv6 data traffic at the Ingress node and tunneled through an MPLS tunnel(SR) to the egress node, the label identifies the IPv6 traffic, and the egress node would POP the label and forward the ipv6 traffic towards the destination.

Policies

The Role of a Routing Policy

Routing Policies are the rules that allow you to control and modify the default behavior of the routing protocols such as BGP and IS-IS. To use routing policies, you configure policies and then apply policies to peer groups or instances.

Attachment Points

Policies are useful when they are applied to routes, for which they need to be made known to routing protocols. In BGP, for example, there are several situations where policies can be used, the most common of these is defining import and export policy. The policy attachment point is the point in which an association is formed between a specific protocol entity, in this case, a BGP neighbor, and a specific named policy.

RtBrick supports attaching a BGP routing policy at two levels:

- Peer group address-family level
- Instance address-family level

In each case, you can apply the policy as an import or export policy and filter. As expected, import filters determine which routing updates are accepted and export filters determine which routes are advertised to other peers.

Policy Processing

An import policy, when applied to an address family at the peer group level, examines all *incoming* routes from all BGP peers in the peer group, but only for that address family.

An export policy, when applied to an address family at the peer group level,

examines all outgoing routes to all BGP peers in the peer group, but only for that address family.

At the instance level, routing policies that are applied to an address family can work as import or export policies, but for the instances as a whole.

An import policy, when applied to an address family at the instance level, examines all incoming routes before accepting the information only from global or default tables to other instances or VRF tables.

An export policy, when applied to an address family at the instance level, examines all outgoing routes before sending the information from the VRF to global, and then to the VPN table (default).

BGP Communities

BGP communities are a way to tag routes with additional information that can be used for routing decisions and routing policies. A BGP community is a collection of destinations that share a common property. It allows you to apply actions to that group of destinations as a whole, rather than to each member individually. BGP communities are used to provide an additional capability to tag routes and thereby, modify BGP routing policies.

Communities can influence routing decisions such as accept, reject, preference, and redistribution. RBFS allows various operations such as appending, modifying, or deleting communities as the route travels from one router to another. A BGP community is an optional attribute that can be tagged with a route. The AS path attribute contains community information, which is used to identify community members. It allows for route manipulation without requiring multiple route filters.

RBFS supports three types of BGP communities for implementing complex routing policies and effectively controlling traffic across diverse and large-scale networks.

Standard Communities

These are used to control routing policies and are represented by a 32-bit number. They include well-known Communities such as no-export, no-advertise, and so on.

Extended Communities

Extended Communities provide functionalities beyond what standard communities

offer. They are represented by 64-bit number and are displayed as two 32-bit numbers. They include additional fields such as type and sub-type, providing more granularity and the ability to carry additional information. Types: These include route targets, route origin, and other specialized community types that extend.

Large Communities

Represented as a 96-bit number, large communities consist of three 32-bit numbers separated by colons (for example, 64512:100:200). They provide space for tagging routes with extensive information and are easier to use in global policies. Large communities are used in large-scale deployments due to the larger addressing space.

Support for Allow As In

The Allow AS In feature enables BGP routers to receive and process routes even if the routes carry the router's autonomous system number in the 'AS-Path' attribute. Usually, a BGP router discards routes if the 'AS-Path' attribute contains its autonomous system number to prevent loops. However, with the "Allow AS In" feature, such routes can be accepted and routed to the destination without being rejected. You can specify the allow-as-in option value in the peer configuration. For example, if you specify the value '5', the router accepts BGP routes that contain its own AS number (in the AS path) up to 5 times.

BGP Best Path Selection Algorithm

BGP routers typically receive multiple paths to the same destination. A BGP router forms a neighbor relationship by connecting to its neighbors and exchanging the routes, once the connection is established. The BGP route selection algorithm decides which is the best path to install in the IP routing table and to use for traffic forwarding.

BGP Best Path Selection Algorithm

The algorithm eliminates all routes whose next hop is not reachable. Circular route resolution is considered for route resolution.

The algorithm for determining all the routes that have the same route prefix is as follows:

1. The first route selection is performed based on the lowest route source. Route

from the local route source is always preferred over the received route. For example, when there is the same prefix route that is redistributed and received from a neighbor, the local (redistributed route) is always preferred. The locally learned route is preferred over the locally crossed or remote crossed route (in the case of VPN, a route might be learned locally in the VRF. The same prefix might be received from the remote as VPNv4. After importing into the VRF routing table, a locally learned route is preferred over the remote local crossed route).

2. Prefer the path with the highest local preference if the route source is the same. If a path does not have a local preference attribute (for example, it is received from an eBGP peer), then it is considered to have the local preference assigned in the given BGP instance. The show bgp summary command shows the local preference assigned in the system. This can be changed using the set local-preference value.
3. Prefer the route with the shortest AS path, if no route originated. If there is no AS_PATH attribute, then it is assumed to be of length 0. A single AS_SET is considered to be a length of 1.
4. Prefer the path with the lowest origin type, if the AS path length is the same as all the paths. The available three values include IGP, EGP and Incomplete. The lowest value is IGP and the highest value is Incomplete.
5. Prefer the path with the lowest Multi Exit Discriminator (MED), if the original codes are the same. (By default, MED values are only compared when routes are learned from the same AS. Routes without MED values are treated as if they have a MED value of 0, which is the lowest and, therefore, always the most preferred value.)
6. Prefer external BGP learned routes over internal BGP routes at this point after comparing the route type (internal BGP and external BGP).
7. Prefer the path whose next hop is resolved through the IGP route with the lowest metric.
8. Prefer the length with a shorter CLUSTER length path. If the CLUSTER attribute is not present, the length is assumed to be 0.
9. Prefer the path from the peer with the lowest router ID. For any path with an originator ID attribute, substitute the originator ID for the router ID during router ID comparison.
10. Prefer the lowest peer IP address as the tie-breaker, if the router-id is the same for both sessions. This is for BGP to make route selections in case of multiple

peerings are used between the same routers.

11. If add path is enabled, then the same peer might advertise multiple paths for the same prefix. The path with a lower send path ID is preferred.

The BGP best path selection algorithm also provides a mechanism to discard paths that are not considered candidates for the best path. The following paths are discarded:

- The paths for which next-hops are not resolved.
- The paths originated from an eBGP neighbor if a local AS is shown in the AS-PATH attribute.
- If the BGP enforce-first-as attribute is enabled and the update does not contain the AS number of the neighbor as the first AS number in the AS-SEQUENCE attribute.
- The paths which are marked as Received-only.

Support for Upstream BGP Route Export into VRFs of Peering Customers

This feature enables service providers to export or leak the upstream BGP routes into the VRFs for advertisement to peering customers. Certain peering customers usually do not require all the upstream BGP routes that the service provider receives. Instead, they want routes only from specific upstream providers. This feature gives peering customers more control over the upstream transit providers and they can choose their preferred upstream neighbor.

It allows service providers to selectively leak selected BGP routes from one instance to another without having to install the routes in the forwarding path in order to conserve the forwarding hardware resources. The leaked or exported routes do not get installed in peering customer VRFs. The feature offers an option to install the default route in the customer VRF that points to the upstream neighbor. It enables forwarding customer traffic towards the internet, connecting the customer site with external networks without requiring each specific route to be installed.

Policy to Notify BGP of Nexthop Changes for VPN Route Label Updates

The nexthop change via policy is notified to BGP and this will trigger a change in label. This notification enables BGP to update the labels for those routes.

2.3.2. BGP Configuration

Configuration Hierarchy

The diagram illustrates the BGP configuration hierarchy. All BGP configuration is done within an instance, for example the default instance or a VPN service instance. The instance configuration hierarchy includes parameters required for BGP but not part of the BGP configuration hierarchy itself. The BGP instance configuration hierarchy includes parameters which are generic to the respective BGP instance. The sub-hierarchies include parameters which are specific to address families, peer groups, and peers.

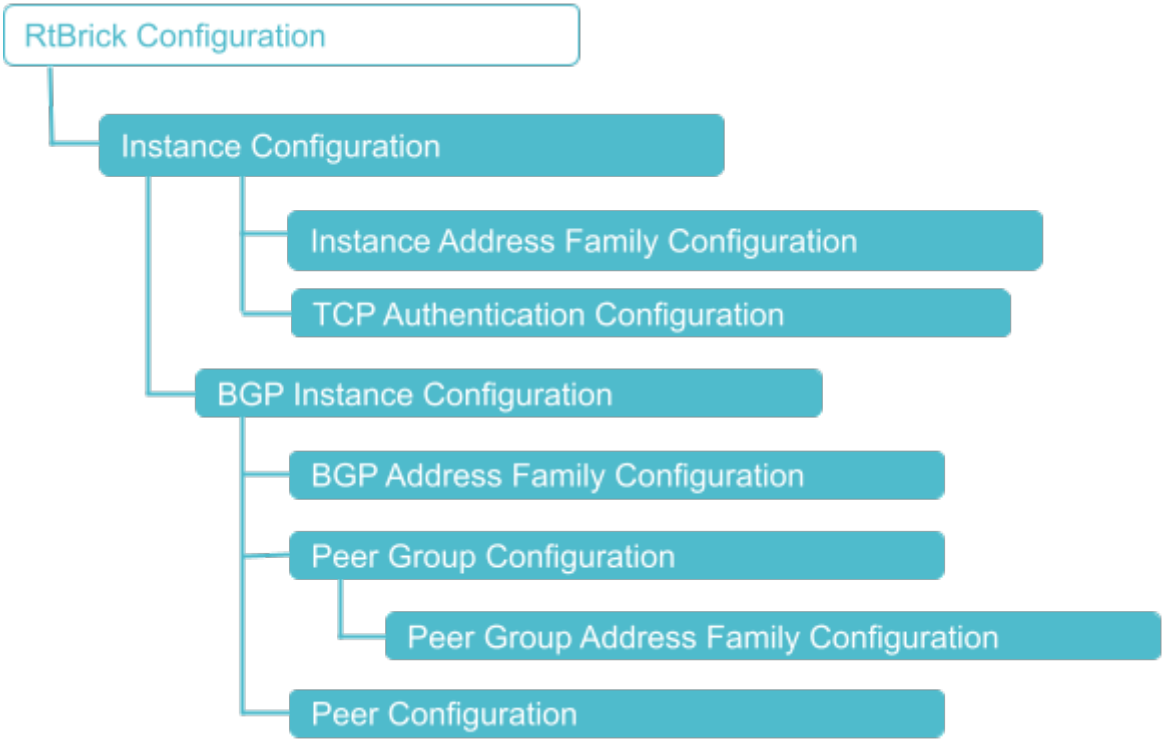


Figure 7. BGP Configuration Hierarchy

Configuration Syntax and Commands

The following sections describe the BGP configuration syntax and commands.

Instance Configuration

The instance configuration hierarchy includes parameters that are required for or used by BGP, but that are not part of the BGP protocol configuration hierarchy itself.

Route distinguishers and router IDs are configured directly at the instance hierarchy.

Syntax:

set instance <instance-name> <attribute> <value>

Attribute	Description
route-distinguisher <as-number|ipv4-address:id>	The route distinguisher (RD) uniquely defines routes within an IPv4 network. PE routers use route distinguishers to identify which VPN a packet belongs to. Supported formats are <as-number:id> or <ipv4-address:id>.  If you want to use the format <as-number:id> with a 4-byte ASN, specify it with an "L". For example, set instance services route-distinguisher 4200000000L:101
ipv4-router-id <ipv4-address>	The router ID of the routing instance.

The example configuration below configures the IPv4 router ID and route distinguisher for the instance services.

```
set instance services ipv4-router-id 198.51.100.41
set instance services route-distinguisher 198.51.100.41:101
commit
```

```
supervisor@leaf1: cfg> show config instance services
{
  "rtbrick-config:instance": {
    "name": "services",
    "ipv4-router-id": "198.51.100.41",
    "route-distinguisher": "198.51.100.41:101",
```

```
    <...>
  }
}
```

To access the RESTCONF API that corresponds to this CLI, click here.

Address Families

At the instance address family hierarchy, you can enable or disable address families for the instance, and configure parameters like route targets.



The default settings depend on the instance. For the 'default' instance, the IPv4 and IPv6 unicast, multicast, and labeled unicast, as well as the MPLS unicast address families are enabled by default. For any non-default instance, no address family is enabled by default and needs to be enabled by configuration.

Syntax:

set instance <instance-name> **address-family** <afi> <safi> <attribute> <value>

Attribute	Description
<afi>	Address family identifier (AFI). Supported values: ipv4, ipv6, or mpls
<safi>	Subsequent address family identifier (SAFI). Supported values: unicast, labeled-unicast, or multicast

Attribute	Description
route-target (import | export) <rt-value>	Route targets (RT) are used to transfer routes between VPN instances. The RT identifies a subset of routes that should be imported to or exported from a particular VPN instance. You can configure a RT for importing or exporting routes or both.  If you want to use the format <as-number:id> with a 4-byte ASN, specify it with an "L". For example, set instance services address-family ipv4 unicast route-target export target:4200000000L:14
policy (import | export) <policy-name>	There are two attachment points for BGP policies. At this configuration hierarchy, you can attach import or export policies to the instance. These policies apply when routes are imported from the BGP protocol into the instance, or exported from the instance to the BGP protocol.

The example configuration below defines policy and route targets for both IPv4 and IPv6 unicast address families within the services instance.

```
set instance services address-family ipv4 unicast policy export MY_V4_POLICY
set instance services address-family ipv4 unicast route-target import
target:198.51.100.70:14
set instance services address-family ipv4 unicast route-target export
target:198.51.100.70:14
set instance services address-family ipv6 unicast policy export MY_V6_POLICY
set instance services address-family ipv6 unicast route-target import
target:198.51.100.70:16
set instance services address-family ipv6 unicast route-target export
target:198.51.100.70:16
commit
```

```
supervisor@leaf1: cfg> show config instance services
{
  "rtbrick-config:instance": {
    "name": "services",
    <...>
    "address-family": [
      {
        "afi": "ipv4",
        "safi": "unicast",
        "policy": {
```

```
          "export": "MY_V4_POLICY"
        },
        "route-target": {
          "import": "target:198.51.100.70:14",
          "export": "target:198.51.100.70:14"
        }
      },
      {
        "afi": "ipv6",
        "safi": "unicast",
        "policy": {
          "export": "MY_V6_POLICY"
        },
        "route-target": {
          "import": "target:198.51.100.70:16",
          "export": "target:198.51.100.70:16"
        }
      }
    ],
    <...>
  }
}
```


To access the RESTCONF API that corresponds to this CLI, click here.

TCP Authentication Configuration

In the instance TCP authentication hierarchy, you can optionally enable MD5 or HMAC-SHA-1-96, HMAC-SHA-256-128, or AES-128-CMAC-96 authentication. Authentication is not configured for BGP directly but for the TCP sessions used by BGP. It is necessary to bind authentication to a peer in order for the authentication to work. For details about configuring a BGP Peer, see the section Peer Configuration.

BGP TCP authentication is not backward compatible.

Syntax:

set instance <instance> **tcp authentication** <authentication-id> <attribute> <value>

Attribute	Description
<authentication-id>	Authentication identifier
type <type>	Authentication identifiers such as MD5

Attribute	Description
type <type>	Authentication identifiers such as MD5 or HMAC-SHA-1-96,HMAC-SHA-256-128 or AES-128-CMAC-96
key1-id <key1-id>	Key ID1 of the receiver
key1-encrypted-text <key1-encrypted-text>	Encrypted text of key1
key1-plain-text <key1-plain-text>	Plain text of key1
key2-id <key2-id>	Key ID2 of the receiver
key2-encrypted-text <key2-encrypted-text>	Encrypted text of key2
key2-plain-text <key2-plain-text>	Plain text of key2

The example below configures MD5 authentication with two keys for the default TCP instance.

```
set instance default tcp authentication auth1 type MD5
set instance default tcp authentication auth1 key1-id 10
set instance default tcp authentication auth1 key1-encrypted-text
"$2784cfa7523916c8cc5dfeba83562cbb4"
set instance default tcp authentication auth1 key2-id 20
set instance default tcp authentication auth1 key2-encrypted-text
"$2e9bb845e3cfcf8173973029e5c1d90d6"
commit
```

```
{
    "rtbrick-config:tcp": {
      "authentication": [
        {
          "authentication-id": "auth1",
          "type": "MD5",
          "key1-id": 10,
          "key1-encrypted-text": "$2784cfa7523916c8cc5dfeba83562cbb4",
          "key2-id": 20,
          "key2-encrypted-text": "$2e9bb845e3cfcf8173973029e5c1d90d6"
        }
      ]
    }
  }
```

API To access the RESTCONF API that corresponds to this CLI, click here.

BGP Instance Configuration

At this configuration hierarchy, you configure BGP protocol parameters which are generic to the BGP instance.

Syntax:

set instance <instance-name> **protocol bgp** <attribute> <value>

Attribute	Description
host-name <host-name>	The name of the BGP host, to a maximum of 64 characters `
domain-name <domain-name>`	The name of the BGP routing domain, to a maximum of 64 characters
enforce-first-as <enable|disable>	By default, the BGP routing process enforces the First AS feature. It discards updates received from an eBGP peer if the peer does not list its own AS number as the first segment in the AS_PATH BGP attribute. Disable the First AS feature to accept updates without the peer's source AS matching the first AS in the AS_PATH attribute.
local-as <as-number>	The AS number in four-byte format. The numbers allowed are from 1 to 4294967295.
local-preference <preference-value>	The local preference for the BGP protocol. The numbers allowed are from 0 to 4294967295. The local preference is used to select the exit path for an AS.
med <med-value>	The BGP Multi-Exit Discriminator (MED) value. The numbers allowed are from 0 to 4294967295. When an AS has multiple links to another AS, the MED value is used to determine the exit to use to reach the other AS.

Attribute	Description
protocol-preference (internal | external) <preference-value>	Protocol preference of routes learned by eBGP ('external'), iBGP ('internal'), or both. This preference is used to select routes learned from multiple protocols. Lower values indicate higher preference. Range: 1 - 255.
router-id <router-id>	Router identifier in IPv4 format
cluster-id <cluster-identifier>	The cluster ID associates routers in a group within a BGP routing instance. Routers belong to the same cluster if they have the same cluster-ID. The cluster ID is formatted as an IPv4 address.
timer hold-time <seconds>	Hold timer in seconds.
timer keepalive <seconds>	Keep a live timer in seconds.
bestroute-selection <ignore-criteria>	Modify the BGP Best Path selection algorithm. For details, see the section Configuring BGP Best Path Selection.
malformed-update ignore	Ignores malformed updates, allowing the BGP session to remain active. For details, see the section [bgpug:bgp_config_cmds:::malformed-update].

The example below configures various global BGP parameters for the default instance, including cluster ID, domain name, host name, local AS, local preference, router ID, protocol preferences, and hold/keepalive timers.

```
set instance default protocol bgp cluster-id 198.51.100.51
set instance default protocol bgp domain-name rtbrick.com
set instance default protocol bgp host-name spine1
set instance default protocol bgp local-as 4200000100
set instance default protocol bgp local-preference 50
set instance default protocol bgp router-id 198.51.100.51
set instance default protocol bgp protocol-preference internal 180
set instance default protocol bgp protocol-preference external 20
set instance default protocol bgp timer hold-time 30
set instance default protocol bgp timer keepalive 10
commit
```

```
supervisor@spine1: cfg> show config instance default protocol bgp
{
  "rtbrick-config:bgp": {
    "cluster-id": "198.51.100.51",
```

```
    "domain-name": "rtbrick.com",
    "host-name": "spine1",
    "local-as": 4200000100,
    "local-preference": 50,
    "router-id": "198.51.100.51",
    "protocol-preference": {
      "internal": 180,
      "external": 20
    },
    "timer": {
      "hold-time": 30,
      "keepalive": 10
    },
    <...>
}
```

API To access the RESTCONF API that corresponds to this CLI, click here.

Configuring Protocol Preference Per Address Family

RBFS supports for protocol preference configuration per address family basis in BGP.

Syntax:

set instance <instance> **protocol** <protocol> **address-family** <AFI> <SAFI> **protocol-preference** [**internal** | **external**] <preference-value>

Attribute	Description
<instance>	Name of the routing instance.
<protocol>	Name of the protocol (e.g., bgp).
<AFI>	Address Family Identifier (e.g., ipv4, ipv6).
<SAFI>	Subsequent Address Family Identifier (e.g., unicast, labeled-unicast).
[internal | external] <preference-value>	Preference value for internal (IBGP) and external (EBGP) routes. Lower values indicate higher preference. Range: 1 - 255.

The example below configures the protocol preference for external EBGP peer routes in the BGP labeled-unicast address family within the default routing instance. The preference value indicates the priority of the routes for RIB to choose best routing among different protocols of same prefix type, with lower values

being more preferred.

```
set instance default protocol bgp address-family ipv4 labeled-unicast protocol-
preference external 10
commit
```

```
supervisor@spine1: cfg> show config instance default protocol bgp address-family
ipv4 labeled-unicast protocol-preference
{
  "rtbrick-config:protocol-preference": {
    "external": 10
  }
}
```

The example below configures the protocol preference for internal IBGP peer routes in the BGP labeled-unicast address family within the default routing instance. The preference value indicates the priority of the routes for RIB to choose best routing among different protocols of same prefix type, with lower values being more preferred.

```
set instance default protocol bgp address-family ipv4 labeled-unicast protocol-
preference internal 10
commit
```

```
supervisor@spine1: cfg> show config instance default protocol bgp address-family
ipv4 labeled-unicast protocol-preference
{
  "rtbrick-config:protocol-preference": {
    "internal": 10
  }
}
```

Configuring BGP Best Path Selection

RBFS can be configured to ignore certain criteria when selecting the BGP best route. It is recommended to exercise extreme caution when doing this, as this can cause unexpected results such as black holes and routing loops.

Syntax:

set instance <instance-name> **protocol bgp bestroute-selection** <criteria-to-ignore>

Criteria to ignore	Description
ignore-as-path	Ignore AS Path during best route selection
ignore-cluster-length	Ignore cluster-length during best route selection
ignore-igp-metric	Ignore igp metric during best route selection
ignore-local-preference	Ignore local-preference during best route selection
ignore-med	Ignore MED during best route selection
ignore-origin	Ignore origin during best route selection
ignore-route-source	Ignore route-source during best route selection
ignore-validation-state	Ignore RPKI validation state during best route selection

The example below enables the BGP best path selection process to ignore the route source when determining the best route.

```
set instance default protocol bgp bestroute-selection ignore-route-source true
```

```
supervisor@rtbrick>LEAF01: cfg> show config instance default protocol bgp bestroute-selection
{
  "rtbrick-config:bestroute-selection": {
    "ignore-route-source": "true"
  }
}
```

Options for Handling Malformed BGP Update Packets

A malformed Network Layer Reachability Information (NLRI) within a BGP UPDATE message typically results in a session reset, leading to route instability and flapping. To prevent this, a new CLI option has been introduced that will ignore such malformed updates (Per RFC 7606), allowing the BGP session to remain active.

Syntax:

```
set instance <instance> protocol bgp malformed-update ignore
```

Attribute	Description
<instance>	Name of the routing instance.
malformed-update ignore	Ignores malformed updates, allowing the BGP session to remain active.

The following example configures a network device to ignore malformed BGP update messages for the default BGP instance.

```
set instance default protocol bgp malformed-update ignore
```

```
{
  "rtbrick-config:bgp": {
    "malformed-update": "ignore"
  }
}
```

BGP Address Family Configuration

This configuration hierarchy refers to parameters that are specific to address families but generic to the BGP instance, as opposed to peer-group specific address families configuration. At this hierarchy, you can enable or disable address families for BGP, and configure various features specific to the address family.

RBFS offers support for a configurable route resolution policy. Initially, RBFS will attempt to resolve the BGP routes using primary resolve-nexthop afi/safi configuration. In case of failure, RBFS will then proceed to resolve the BGP routes using the secondary-nexthop afi/safi configuration.

Syntax:

set instance <instance-name> **protocol bgp address-family** <afi> <safi> <attribute> <value>

Attribute	Description
<afi>	Address family identifier (AFI). Supported values: ipv4, or ipv6

Attribute	Description
<safi>	Subsequent address family identifier (SAFI). Supported values: unicast, labeled-unicast, vpn-unicast, multicast, or vpn-multicast
default-information originate <true|false>	Generate and distribute a default route information
download-count <count>	Forward packets over multiple paths, set maximum prefixes to use
multipath <number>	Enable load sharing among multiple BGP paths  The default ECMP Maximum Next-hop Count is limited to 8; however, this limit varies depending on the platform that RBFS supports. For details on the limits set for the ECMP Maximum Next-hop Count on the platforms, refer to the undefined/techdocs/current/platform/resource_limit.html[Resource Limits/Feature Support] section of the *Platform Guide*.
retain-route-target (enable|disable)	Retain VPN routes for all route targets, by default this feature is enabled
resolve-nexthop afi <afi>	Address family to resolve the next-hop
resolve-nexthop safi <safi>	Sub-address family to resolve the next-hop
resolve-nexthop-secondary afi <afi>	Address family to resolve the next-hop when the primary route resolution fails
resolve-nexthop-secondary safi <safi>	Sub-address family to resolve the next-hop when the primary route resolution fails
redistribute <source>	Enable the redistribution feature to dynamically inject specific types of routes into the BGP protocol. Supported route sources are direct, igmp, ipoe, isis, ospf, pim, ppp, static, and arp-nd.

Attribute	Description
redistribute <source> policy <policy>	Attach a policy to the redistribution process
srgb base <value>	Segment Routing Global Block (SRGB) start label. The SRGB is the range of label values reserved for segment routing (SR). These values are assigned as segment identifiers (SIDs) to SR-enabled network nodes and have global significance throughout the routing domain. SRGB is supported for labeled unicast only.
srgb index <value>	Segment Routing Global Block (SRGB) index
srgb range <value>	Segment Routing Global Block (SRGB) label range  For details on the supported label ranges, see the undefined/techdocs/current/platform/resource_limit.html#static-system-dynamic-label-ranges[Static, System, and Dynamic Label Ranges] section in the Platform Guide.
inter-as-option-ab enable	Enables Inter-AS Option AB for the specified address family. For details, see the Inter-AS Option A-B Configuration section of this guide.

The example configuration below enables various IPv4 and IPv6 address families for the default BGP instance, including VPN unicast and labeled unicast with specific SRGB parameters.

```
set instance default protocol bgp address-family ipv4 vpn-unicast
set instance default protocol bgp address-family ipv6 labeled-unicast srgb base
5000
set instance default protocol bgp address-family ipv6 labeled-unicast srgb range
1000
set instance default protocol bgp address-family ipv6 labeled-unicast srgb index
11
set instance default protocol bgp address-family ipv6 unicast
set instance default protocol bgp address-family ipv6 vpn-unicast
commit
```

```
supervisor@spine1: cfg> show config instance default protocol bgp
{
```

```
  "rtbrick-config:bgp": {
    <...>
    "address-family": [
      {
        "afi": "ipv4",
        "safi": "vpn-unicast"
      },
      {
        "afi": "ipv6",
        "safi": "labeled-unicast",
        "srgb": {
          "base": 5000,
          "range": 1000,
          "index": 11
        }
      },
      {
        "afi": "ipv6",
        "safi": "unicast"
      },
      {
        "afi": "ipv6",
        "safi": "vpn-unicast"
      }
    ],
    <...>
  }
}
```

The example configuration below redistributes direct, PPP, ARP-ND, and static routes into BGP for both IPv4 and IPv6 unicast address families within the services instance.

```
set instance services protocol bgp address-family ipv4 unicast redistribute direct
set instance services protocol bgp address-family ipv4 unicast redistribute ppp
set instance services protocol bgp address-family ipv4 unicast redistribute arp-nd
set instance services protocol bgp address-family ipv4 unicast redistribute static
set instance services protocol bgp address-family ipv6 unicast redistribute direct
set instance services protocol bgp address-family ipv6 unicast redistribute ppp
set instance services protocol bgp address-family ipv6 unicast redistribute static
commit
```

```
supervisor@leaf1: cfg> show config instance services protocol bgp
{
  "rtbrick-config:bgp": {
    <...>
    "address-family": [
      {
        "afi": "ipv4",
        "safi": "unicast",
        "redistribute": [
          {
            "source": "direct"
          },
          {
            "source": "ppp"
```

```
          },
          {
            "source": "arp-nd"
          },
          {
            "source": "static"
          }
        ]
      },
      {
        "afi": "ipv6",
        "safi": "unicast",
        "redistribute": [
          {
            "source": "direct"
          },
          {
            "source": "ppp"
          },
          {
            "source": "static"
          }
        ]
      }
    ]
  }
}
```

The example configuration below shows how to redistribute direct, PPP, and static routes into BGP for both IPv4 and IPv6 unicast address families within a services instance.

```
set instance services protocol bgp address-family ipv4 unicast redistribute direct
policy MY_REDISTRIBUTION_POLICY
set instance services protocol bgp address-family ipv4 unicast redistribute ppp
set instance services protocol bgp address-family ipv4 unicast redistribute static
set instance services protocol bgp address-family ipv6 unicast redistribute direct
policy MY_REDISTRIBUTION_POLICY
set instance services protocol bgp address-family ipv6 unicast redistribute ppp
set instance services protocol bgp address-family ipv6 unicast redistribute static
commit
```

```
supervisor@leaf1: cfg> show config instance services protocol bgp
{
  "rtbrick-config:bgp": {
    <...>
    "address-family": [
      {
        "afi": "ipv4",
        "safi": "unicast",
        "redistribute": [
          {
            "source": "direct"
            "policy": "MY_REDISTRIBUTION_POLICY"
          },
          {
```

```
            "source": "ppp"
          },
          {
            "source": "static"
          }
        ]
      },
      {
        "afi": "ipv6",
        "safi": "unicast",
        "redistribute": [
          {
            "source": "direct"
            "policy": "MY_REDISTRIBUTION_POLICY"
          },
          {
            "source": "ppp"
          },
          {
            "source": "static"
          }
        ]
      }
    ]
  }
}
```

In the example below, RBFS would resolve the BGP routes in the IPv4 labeled-unicast RIB. If this fails, then the routes would be resolved in IPv4 unicast RIB.

```
set instance default protocol bgp address-family ipv4 unicast resolve-nexthop afi
ipv4
set instance default protocol bgp address-family ipv4 unicast resolve-nexthop safi
labeled-unicast
set instance default protocol bgp address-family ipv4 unicast resolve-nexthop-
secondary afi ipv4
set instance default protocol bgp address-family ipv4 unicast resolve-nexthop-
secondary safi unicast
commit
```

```
supervisor@leaf1: cfg> show config instance default protocol bgp address-family
ipv4 unicast
{
  "rtbrick-config:address-family": [
    {
      "afi": "ipv4",
      "safi": "unicast",
      "resolve-nexthop": {
        "afi": "ipv4",
        "safi": "labeled-unicast"
      },
      "resolve-nexthop-secondary": {
        "afi": "ipv4",
        "safi": "unicast"
      }
    }
```

```
  ]
}
```

The example below configures the BGP protocol for IPv4 unicast within the default instance. It then enables the redistribution of ARP and ND (Neighbor Discovery) entries into BGP, applying a policy named ARP_ND_SOURCE_MATCH to control which entries are redistributed.

```
set instance default protocol bgp address-family ipv4 unicast
set instance default protocol bgp address-family ipv4 unicast redistribute arp-nd
set instance default protocol bgp address-family ipv4 unicast redistribute arp-nd
policy ARP_ND_SOURCE_MATCH
```

```
{
  "rtbrick-config:address-family": [
    {
      "afi": "ipv4",
      "safi": "unicast",
      "redistribute": [
        {
          "source": "arp-nd",
          "policy": [
            "ARP_ND_SOURCE_MATCH"
            ]
        }
      ]
    }
  ]
}
```

For details about matching ARP-ND source in policy, see the Matching ARP-ND Source in Policy section of the *Policy User Guide*.

API To access the RESTCONF API that corresponds to this CLI, click here.

Peer Group Configuration

Peer Groups

In BGP, neighbor peers with the same update policies can be grouped to simplify the initial configuration and updates. Peers share the same policies such as route maps, distribution lists, filter lists, update sources, and so on, so peer groups only need one configuration statement for these values.

Syntax:

set instance <instance-name> **protocol bgp peer-group** <peer-group-name> <attribute> <value>

Attribute	Description
local-as <as-number>	Local AS number for the peer group
remote-as <as-number>	Remote AS number for the peer group
any-as <true|false>	Enable dynamic AS negotiation for this peer group
ebgp-multihop <hop-count>	By default, the maximum number of hops between eBGP peers is 1 (direct connection). This hop count overrides the default behavior allowing connectivity between eBGP peers not directly connected.
link-local-nexthop-only <true|false>	Enable BGPv6 peerings using the IPv6 link-local addresses
no-prepend <true|false>	Do not prepend the local AS for advertisements to the peer
replace-as <true|false>	Prepend only the local AS for advertisements to the peer
ttl-security <enable|disable>	Enables or disalbes Generalized TTL Security Mechanism (GTSM).
ttl-limit <ttl-limit>	Specifies the minimum TTL value of packets from the BGP neighbor for TTL Security. The valid range is 1 to 255.

API To access the RESTCONF API that corresponds to this CLI, click here.

Address Families

At this configuration hierarchy, you can enable the address families that shall be supported for the group peers, and enable features specific to the address family. By default, BGP neighbor sessions support the IP4v unicast and multicast address families.

Syntax:

set instance <instance-name> **protocol bgp peer-group** <peer-group-

```
name> address-family <afi> <safi> <attribute> <value>
```

Attribute	Description
<afi>	Address family identifier (AFI). Supported values: ipv4, or ipv6
<safi>	Subsequent address family identifier (SAFI). Supported values: unicast, labeled-unicast, vpn-unicast, multicast, or vpn-multicast
add-path	Negotiate additional path capabilities with these peers, so that more than one path can be active to the peers in the group
default-information originate <true|false>	Generate and advertise a default route to peers in the group
extended-nexthop	Enable extended-next-hop encoding for BGP peer groups to allow the transfer of IPv4 prefixes over an IPv6 connection
nexthop-self <true|false>	Set the advertised BGP nexthop to yourself, this is the default for eBGP
nexthop-unchanged <true|false>	Do not modify the advertised BGP nexthop, this is the default for iBGP
update-nexthop (ipv4-address | ipv6-address) <address>	BGP nexthop address for routes advertised to this peer group
remove-private-as <true|false>	Remove private AS numbers from routes advertised to group peers
route-reflect-client <true|false>	Configure this peer as a route reflector client
policy (import | export) <policy-name>	Apply a routing policy to the peer group

The example configuration below sets up a BGP peer-group named "spine" with specific parameters for IPv4 and IPv6 address families, including the use of link-local nexthops, a remote AS number, and extended nexthop and update nexthop settings for VPN unicast routes.

```
set instance default protocol bgp peer-group spine link-local-nexthop-only true
set instance default protocol bgp peer-group spine remote-as 4200000100
set instance default protocol bgp peer-group spine address-family ipv4 vpn-unicast
extended-nexthop true
set instance default protocol bgp peer-group spine address-family ipv4 vpn-unicast
update-nexthop ipv6-address 2001:db8:0:19::
set instance default protocol bgp peer-group spine address-family ipv6 labeled-
unicast
set instance default protocol bgp peer-group spine address-family ipv6 unicast
set instance default protocol bgp peer-group spine address-family ipv6 vpn-unicast
update-nexthop ipv6-address 2001:db8:0:19::
commit
```

```
supervisor@leaf1: cfg> show config instance default protocol bgp peer-group spine
{
  "rtbrick-config:peer-group": {
    "pg-name": "spine",
    "link-local-nexthop-only": "true",
    "remote-as": 4200000100,
    "address-family": [
      {
        "afi": "ipv4",
        "safi": "vpn-unicast",
        "extended-nexthop": "true",
        "update-nexthop": {
          "ipv6-address": "2001:db8:0:19::"
        }
      },
      {
        "afi": "ipv6",
        "safi": "labeled-unicast"
      },
      {
        "afi": "ipv6",
        "safi": "unicast"
      },
      {
        "afi": "ipv6",
        "safi": "vpn-unicast",
        "update-nexthop": {
          "ipv6-address": "2001:db8:0:19::"
        }
      }
    ]
  }
}
```

The example configuration below defines a BGP peer-group named "ipv4_bgp" with a remote AS, enables TTL security with a limit of 253, and activates both IPv4 and IPv6 unicast address families for this peer-group.

```
set instance default protocol bgp peer-group ipv4_bgp remote-as 4200000100
set instance default protocol bgp peer-group ipv4_bgp ttl-security enable
set instance default protocol bgp peer-group ipv4_bgp ttl-limit 253
set instance default protocol bgp peer-group ipv4_bgp address-family ipv4 unicast
```

```
set instance default protocol bgp peer-group ipv4_bgp address-family ipv6 unicast
commit
```

```
{
  "rtbrick-config:peer-group": [
    {
      "pg-name": "ipv4_bgp",
      "remote-as": 4200000100,
      "ttl-security": "enable",
      "ttl-limit": 253,
      "address-family": [
        {
          "afi": "ipv4",
          "safi": "unicast"
        },
        {
          "afi": "ipv6",
          "safi": "unicast"
        }
      ]
    }
  ]
}
```

API To access the RESTCONF API that corresponds to this CLI, click here.

Maximum Prefix Limit

The BGP Maximum Prefix Limit feature enables you to set a limit for the maximum number of prefixes that a BGP router can receive from its peer router. If a BGP router receives prefixes that exceed the defined limit threshold, the BGP session gets reset and the session goes idle for a pre-defined period.

You can define a period as idle timeout so that the BGP peering gets re-established automatically after the specified time. If you do not specify the idle timeout, the BGP peering does not get re-established until or unless you execute the clear bgp peer command.

Before getting into inactive or idle mode, the router sends a notification message to the peer router about the exceeded threshold with the error code and the sub-code.

You can configure prefix limits for a peer group.

Syntax:

set instance <instance-name> **protocol bgp peer-group** <peer-group-

```
name> address-family <afi> <safi> prefix-limit <attribute> <value>
```

Attribute	Description
<afi>	Address family identifier (AFI). Supported values: ipv4, or ipv6
<safi>	Subsequent address family identifier (SAFI). Supported values: unicast, labeled-unicast, vpn-unicast, or vpn-multicast
count <count>	Number of maximum prefixes that the peer router is allowed to send. The default value is 0. It means no value is configured for prefix limit.
idle-timeout <idle-timeout>	Idle or inactive time after the maximum limit is reached (in minutes). The allowed range is 1 - 2400 min. The default is 'Forever'.

The example configuration below configures a prefix limit of 100 with an idle timeout of 5 seconds for the IPv4 unicast address family within the BGP peer-group "PE2" in the default instance.

```
set instance default protocol bgp peer-group PE2 address-family ipv4 unicast
prefix-limit count 100
set instance default protocol bgp peer-group PE2 address-family ipv4 unicast
prefix-limit idle-timeout 5
commit
```

```
supervisor@L1-STD-2-2002>bm14-tst.fsn.rtbrick.net: cfg> show config instance
default protocol bgp peer-group PE2 address-family ipv4 unicast
{
  "rtbrick-config:address-family": [
    {
      "afi": "ipv4",
      "safi": "unicast",
      "prefix-limit": {
        "count": 100,
        "idle-timeout": 5
      }
    }
  ]
}
```

API To access the RESTCONF API that corresponds to this CLI, click here.

Configure Upstream BGP Route Export into VRFs of Peering Customers

For peering customers, it is required to select and install specific upstream routes in their own dedicated routing tables (VRFs). To achieve this, the routes from a single upstream peer must be distributed to multiple RIBs, one for each customer-specific VRF.

You can configure the Upstream BGP Route Export into VRFs of peering customers.

Syntax:

set instance <instance-name> **protocol bgp peer-group** <peer-group-name> **address-family** <afi> <safi> **export-rib** <name>

Attribute	Description
<instance-name>	Name of the routing instance.
<peer-group-name>	Name of the peer group.
<afi>	Address family identifier (AFI). Supported values: ipv4, or ipv6
<safi>	Subsequent address family identifier (SAFI). Supported values: unicast, labeled-unicast, vpn-unicast, or vpn-multicast
export-rib	Defines in which routing tables (RIBs) the routes from this peer will be installed. The option indicates that the routes learned from the BGP peer are to be installed in multiple RIBs.
peer-default-route	It specifies the default route that is to be installed in the customer's routing table.

The example configuration below configures default route advertisement and export of RIBs for IPv4 unicast within the BGP peer-group "PE2" to peers CE1, CE2, and CE3 in the default instance.

```
set instance default protocol bgp peer-group PE2 address-family ipv4 unicast peer-
default-route CE1
set instance default protocol bgp peer-group PE2 address-family ipv4 unicast peer-
default-route CE2
set instance default protocol bgp peer-group PE2 address-family ipv4 unicast peer-
default-route CE3
```

```
set instance default protocol bgp peer-group PE2 address-family ipv4 unicast
export-rib CE1
set instance default protocol bgp peer-group PE2 address-family ipv4 unicast
export-rib CE2
set instance default protocol bgp peer-group PE2 address-family ipv4 unicast
export-rib CE3
commit
```

```
supervisor@rtbrick.net: cfg> show config instance default protocol bgp peer-group
PE2 address-family ipv4 unicast
{
  "rtbrick-config:address-family": [
    {
      "afi": "ipv4",
      "safi": "unicast",
      "peer-default-route": [
        "CE1",
        "CE2",
        "CE3"
        ],
      "export-rib": [
        {
          "instance": "CE1"
        },
        {
          "instance": "CE2"
        },
        {
          "instance": "CE3"
        }
      ]
    }
  ]
}
```

API To access the RESTCONF API that corresponds to this CLI, click here.

Peer Configuration

Once peer groups have been defined, BGP peers can be configured at the peer configuration hierarchy. A peer can be specified by address, or by interface when using IPv6 auto-discovered neighbors and link-local addresses. Furthermore, it is possible to configure TCP authentication and bind it to a peer.

Syntax to configure a BGP peer by address:

set instance <instance-name> **protocol bgp peer** (ipv4 | ipv6) <peer-address> <update-source> **peer-group** <peer-group>

Syntax to configure a BGP peer using IPv6 link-local addresses:

set instance <instance-name> **protocol bgp peer interface** <name> **peer-group** <peer-group>

Syntax to configure TCP Authentication for BGP peers:

set instance <instance-name> **protocol bgp peer** (ipv4 | ipv6) <peer-address> <update-source> **authentication-id** <authentication-id>

Attribute	Description
interface <name>	Enable BGP peer using IPv6 link-local addresses
ipv4 <peer-address>	IPv4 address of a BGP peer
ipv6 <peer-address>	IPv6 address of a BGP peer
allow-as-in <value>	Specify the value for allow-as-in. Allowed range of value 1 - 10.
<update-source>	Local IP address to be used for the peering
peer-group <peer-group>	Assign the peer to a peer group
deactivate	Deactivate a configured peer
authentication-id <authentication-id>	Authentication identifier

The example configuration below configures update source for a BGP peer to a specific IP address and assigns the peer to the "spine" peer-group within the default instance.

```
set instance default protocol bgp peer ipv4 peer-address 198.51.100.82 update-
source 198.51.100.81
set instance default protocol bgp peer ipv4 peer-address 198.51.100.82 peer-group
spine
commit
```

```
supervisor@rtbrick: cfg> show config instance default protocol bgp peer

{
  "rtbrick-config:peer": {
    "ipv4": [
```

```
      {
        "peer-address": "198.51.100.82",
        "update-source": "198.51.100.81",
        "peer-group": "spine"
      }
    ]
  }
}
```

The example configuration below assigns a specific interface to the "spine" peer-group within the BGP protocol configuration of the default instance.

```
set instance default protocol bgp peer interface ifl-0/0/1/1 peer-group spine
commit
```

```
supervisor@rtbrick: cfg> show config instance default protocol bgp peer
{
  "rtbrick-config:peer": {
    "interface": [
      {
        "name": "ifl-0/0/1/1",
        "peer-group": "spine"
      }
    ]
  }
}
```

The example configuration below applies an authentication ID to a BGP peer interface and assigns that interface to the "spine" peer-group within the default instance.

```
set instance default protocol bgp peer interface ifl-0/0/1/1 authentication-id
auth1
set instance default protocol bgp peer interface ifl-0/0/1/1 peer-group spine
commit
```

```
supervisor@rtbrick: cfg> show config instance default protocol bgp peer
{
  "rtbrick-config:peer": {
    "interface": [
      {
        "name": "ifl-0/0/1/1",
        "authentication-id": "auth1",
        "peer-group": "spine"
      }
    ]
  }
}
```

API To access the RESTCONF API that corresponds to this CLI, click here.

Inter-AS Option A-B Configuration

The VPN Option A-B Interconnect solution is aimed at conserving label space in spine devices by using a single static label for multiple VPN prefixes.

Option-B Label Space Conservation

The MSANs are connected via an L3VPN private network. Traditionally, spines allocate a new service label (Option B) for each next hop and label when advertising VPN prefixes to the Route Reflector (RR) in the IP2 core. This can lead to a large number of MPLS Option B labels being installed in the spines. This solution addresses this by enabling a more efficient label allocation.

To conserve label space, a new MSAN POTS instance is configured on the spines with a static label. All MSAN routes are installed in this instance, and their service labels are replaced with the single static label before being forwarded to the RR. When data packets arrive from the core, an IP lookup followed by an MPLS push is performed, and packets are forwarded towards the leaf using this single label.

The key features of this solution are:

- Supports the static label for an address family (IPv4 unicast / IPv6 unicast).
- Supports enabling/disabling of VPN address family (IPv4 vpn-unicast / IPv6 vpn-unicast).
- Supports replacing the service label with the configured static instance label if the prefix RT matches the import RT of the instance.

Configuring Inter-AS Option A-B

The inter-as-option-ab parameter needs to be enabled within the BGP configuration for vpn-unicast address families (both IPv4 and IPv6) under the relevant instance.

Syntax:

set instance <instance-name> **protocol bgp address-family** <afi> <safi> <attribute> <value>

Attribute	Description
<afi>	Address family identifier (AFI) for the address family (IPv4 / IPv6)
<safi>	Subsequent address family identifier (SAFI) for the address family (vpn-unicast)
inter-as-option-ab enable	Enables Inter-AS Option AB for the specified address family.

The following example enables Inter-AS Option AB for both IPv4 and IPv6 VPN-unicast address families under the default instance:

```
set instance default protocol bgp local-as 65001
set instance default protocol bgp address-family ipv4 unicast
set instance default protocol bgp address-family ipv4 vpn-unicast inter-as-option-
ab enable
set instance default protocol bgp address-family ipv6 vpn-unicast inter-as-option-
ab enable
commit
```

Configuration Example:

```
"rtbrick-config:instance": [
  {
    "name": "default",
    "protocol": {
      "bgp": {
        "local-as": 65001,
        "address-family": [
          {
            "afi": "ipv4",
            "safi": "unicast"
          },
          {
            "afi": "ipv4",
            "safi": "vpn-unicast",
            "inter-as-option-ab": "enable"
          },
          {
            "afi": "ipv6",
            "safi": "vpn-unicast",
            "inter-as-option-ab": "enable"
          }
        ]
      }
    }
  }
]
```

Configuring Static Label

Syntax:

set instance <instance-name> **protocol bgp address-family** <afi> <safi> <attribute> <value>

Attribute	Description
<afi>	Address family identifier (AFI) for the address family (IPv4 / IPv6)
<safi>	Subsequent address family identifier (SAFI) for the address family (unicast)
<afi> <safi> label <label>	Static label for IPv4/IPv6 unicast address family.

The following example enables static label for both IPv4 and IPv6 unicast address families under the vrf1 instance:

```
set instance vrf1 protocol bgp address-family ipv4 unicast
set instance vrf1 protocol bgp address-family ipv4 unicast label 400000
set instance vrf1 protocol bgp address-family ipv6 unicast
set instance vrf1 protocol bgp address-family ipv6 unicast label 401000
commit
```

Configuration Example:

```
{
  "rtbrick-config:address-family": [
    {
      "afi": "ipv4",
      "safi": "unicast",
      "label": 400000
    },
    {
      "afi": "ipv6",
      "safi": "unicast",
      "label": 401000
    }
  ]
}
```

Multiple MPLS Label Support for BGP Labeled Unicast

RBFS support for receiving and sending multiple MPLS labels that enable BGP

Label Unicast (BGP-LU) for executing traffic engineering policies (as per RFC8277). RBFS allows the use of up to eight MPLS labels on Q2C and Q2A platforms. You can enable 'multi-label capability' option for both IPv4 and IPv6 labeled-unicast address families to accommodate advanced traffic engineering use cases.

This feature enhances that capability by enabling BGP to advertise multiple MPLS labels stacked together for the same Network Layer Reachability Information (NLRI) or prefix. This capability allows BGP-Labeled Unicast (BGP-LU) to provide detailed forwarding information and to contain complex transport and service topologies. Also, this feature simplifies operations, particularly when controllers manage label stacks centrally.

It allows RBFS routers to receive, process, and advertise BGP LU routes that contain a multiple MPLS labels. It enables the execution of controller-driven traffic engineering policies. Controllers can decide optimized paths using Segment Routing parameters and encode these paths as MPLS label stacks. The RBFS capability to install and push multiple labels on outgoing packets is used to forward traffic along these controller-defined paths.

This feature allows the controller to define optimized paths using Segment Routing, encode them as MPLS label stacks, and advertise them using BGP LU for IPv4 and IPv6. RBFS installs and pushes these labels on outgoing packets to forward traffic along controller-defined paths.

Syntax:

set instance <instance-name> **protocol bgp peer-group** <peer-group> **address-family** [**ipv4** | **ipv6**] **labeled-unicast multi-label-capability true**

Attribute	Description
<instance-name>	Name of the instance.
<afi>	Address family identifier (AFI). Supported values: ipv4, or ipv6
<safi>	Subsequent address family identifier (SAFI). Supported labeled-unicast.
multi-label capability true	Set this to true. It enables both IPv4 and IPv6 labeled-unicast address families to execute advanced traffic engineering policies.

The following configuration enables multi-label-capability under IPv4 and IPv6 labeled-unicast. It allows the BGP peer-group PE2_SDN to negotiate and exchange routes that carry multiple MPLS labels. This applies to both IPv4 and IPv6 address families with SAFI labeled-unicast. This configuration , ensures that the peer can advertise and receive NLRI with a label stack instead of a single label.

Example for IPv4:

```
set instance default protocol bgp peer-group PE2_SDN address-family ipv4 labeled-
unicast multi-label-capability true
```

```
supervisor@rtbrick.net: cfg> show config instance default protocol bgp peer-group
PE2_SDN address-family ipv4 labeled-unicast
{
  "rtbrick-config:address-family": [
    {
      "afi": "ipv4",
      "safi": "labeled-unicast",
      "multi-label-capability": "true"
    }
  ]
}
```

Example for IPv6:

```
set instance default protocol bgp peer-group PE2_SDN address-family ipv6 labeled-
unicast multi-label-capability true
```

```
supervisor@rtbrick.net: cfg> show config instance default protocol bgp peer-group
PE2_SDN address-family ipv6 labeled-unicast
{
  "rtbrick-config:address-family": [
    {
      "afi": "ipv6",
      "safi": "labeled-unicast",
      "multi-label-capability": "true"
    }
  ]
}
```

BGP Sample Configuration

Example 1: BGP Configuration of a Spine Switch (Default Instance only)

```
{
  "ietf-restconf:data": {
    "rtbrick-config:instance": [
```

```
      {
        "name": "default",
        "ipv4-router-id": "198.51.100.51",
        "protocol": {
          "bgp": {
            "domain-name": "rtbrick.com",
            "host-name": "spine1",
            "local-as": 4200000100,
            "address-family": [
              {
                "afi": "ipv4",
                "safi": "vpn-unicast"
              },
              {
                "afi": "ipv6",
                "safi": "labeled-unicast",
                "srgb": {
                  "base": 5000,
                  "range": 1000,
                  "index": 11
                },
                "redistribute": [
                  {
                    "source": "direct"
                  }
                ]
              },
              {
                "afi": "ipv6",
                "safi": "unicast",
                "redistribute": [
                  {
                    "source": "direct"
                  }
                ]
              },
              {
                "afi": "ipv6",
                "safi": "vpn-unicast"
              }
            ],
            "peer": {
              "interface": [
                {
                  "name": "ifl-0/1/1/1",
                  "authentication-id": "auth1",
                  "peer-group": "spine"
                },
                {
                  "name": "ifl-0/2/1/1",
                  "peer-group": "leaf1"
                },
                {
                  "name": "ifl-0/2/2/1",
                  "peer-group": "leaf2"
                }
              ]
            },
            "peer-group": [
              {
                "pg-name": "leaf1",
```

```
            "link-local-nexthop-only": "true",
            "remote-as": 4200000201,
            "address-family": [
              {
                "afi": "ipv4",
                "safi": "vpn-unicast",
                "extended-nexthop": "true",
                "nexthop-unchanged": "true"
              },
              {
                "afi": "ipv6",
                "safi": "labeled-unicast"
              },
              {
                "afi": "ipv6",
                "safi": "unicast"
              },
              {
                "afi": "ipv6",
                "safi": "vpn-unicast",
                "nexthop-unchanged": "true"
              }
            ]
          },
          {
            "pg-name": "leaf2",
            "link-local-nexthop-only": "true",
            "remote-as": 4200000202,
            "address-family": [
              {
                "afi": "ipv4",
                "safi": "vpn-unicast",
                "extended-nexthop": "true",
                "nexthop-unchanged": "true"
              },
              {
                "afi": "ipv6",
                "safi": "labeled-unicast"
              },
              {
                "afi": "ipv6",
                "safi": "unicast"
              },
              {
                "afi": "ipv6",
                "safi": "vpn-unicast",
                "nexthop-unchanged": "true"
              }
            ]
          },
          {
            "pg-name": "spine",
            "link-local-nexthop-only": "true",
            "remote-as": 4200000100,
            "address-family": [
              {
                "afi": "ipv4",
                "safi": "vpn-unicast",
                "extended-nexthop": "true"
              },
              {
```

```
                    "afi": "ipv6",
                    "safi": "labeled-unicast",
                    "nexthop-self": "true"
                  },
                  {
                    "afi": "ipv6",
                    "safi": "unicast",
                    "nexthop-self": "true"
                  },
                  {
                    "afi": "ipv6",
                    "safi": "vpn-unicast"
                  }
                ]
              }
            ]
          }
        }
      }
    ]
  }
}
```

Example 2: BGP Configuration of a Leaf Switch with one VPN Instance

```
{
  "ietf-restconf:data": {
    "rtbrick-config:instance": [
      {
        "name": "default",
        "ipv4-router-id": "198.51.100.53",
        "protocol": {
          "bgp": {
            "domain-name": "rtbrick.com",
            "host-name": "leaf1",
            "local-as": 4200000201,
            "address-family": [
              {
                "afi": "ipv4",
                "safi": "vpn-unicast"
              },
              {
                "afi": "ipv6",
                "safi": "labeled-unicast",
                "srgb": {
                  "base": 5000,
                  "range": 1000,
                  "index": 13
                },
                "redistribute": [
                  {
                    "source": "direct"
                  }
                ]
              },
              {
                "afi": "ipv6",
                "safi": "unicast",
                "redistribute": [
```

```
              {
                "source": "direct"
              }
            ]
          },
          {
            "afi": "ipv6",
            "safi": "vpn-unicast"
          }
        ],
        "peer": {
          "interface": [
            {
              "name": "ifl-0/1/1/1"
              "authentication-id": "auth1",
              "peer-group": "spine"
            },
            {
              "name": "ifl-0/1/2/1",
              "peer-group": "spine"
            }
          ]
        },
        "peer-group": [
          {
            "pg-name": "spine",
            "link-local-nexthop-only": "true",
            "remote-as": 4200000100,
            "address-family": [
              {
                "afi": "ipv4",
                "safi": "vpn-unicast",
                "extended-nexthop": "true",
                "update-nexthop": {
                  "ipv6-address": "2001:db8:0:19::"
                }
              },
              {
                "afi": "ipv6",
                "safi": "labeled-unicast"
              },
              {
                "afi": "ipv6",
                "safi": "unicast"
              },
              {
                "afi": "ipv6",
                "safi": "vpn-unicast",
                "update-nexthop": {
                  "ipv6-address": "2001:db8:0:19::"
                }
              }
            ]
          }
        ]
      }
    },
    {
      "name": "services",
      "ipv4-router-id": "198.51.100.41",
```

```
        "route-distinguisher": "198.51.100.41:101",
        "address-family": [
          {
            "afi": "ipv4",
            "safi": "unicast",
            "policy": {
              "export": "MY_V4_POLICY"
            },
            "route-target": {
              "import": "target:198.51.100.70:14",
              "export": "target:198.51.100.70:14"
            }
          },
          {
            "afi": "ipv6",
            "safi": "unicast",
            "policy": {
              "export": "MY_V6_POLICY"
            },
            "route-target": {
              "import": "target:198.51.100.70:16",
              "export": "target:198.51.100.70:16"
            }
          }
        ],
        "protocol": {
          "bgp": {
            "domain-name": "rtbrick.com",
            "host-name": "leaf1",
            "local-as": 65003,
            "address-family": [
              {
                "afi": "ipv4",
                "safi": "unicast",
                "redistribute": [
                  {
                    "source": "direct"
                  },
                  {
                    "source": "ppp"
                  },
                  {
                    "source": "static"
                  }
                ]
              },
              {
                "afi": "ipv6",
                "safi": "unicast",
                "redistribute": [
                  {
                    "source": "direct"
                  },
                  {
                    "source": "ppp"
                  },
                  {
                    "source": "static"
                  }
                ]
              }
```

```
            ]
          }
        }
      }
    ]
  }
}
```

2.3.3. BGP Operational Commands

BGP Show Commands

The BGP show commands provide detailed information about the BGP protocol operation and BGP routes.

BGP Summary

This command displays BGP protocol parameters like attributes or timers that are generic to the BGP instance.

Syntax:

show bgp summary <option>

Option	Description
-	Without any option, the commands displays the information for all instances.
instance <instance-name>	BGP summary information for the given instance.

Example: BGP summary for the default instance

```
supervisor@rtbrick: op> show bgp summary instance default
Instance: default
  General information
    Hostname: PE1, Domain name:
    Local AS: 1000, Version: 4
    Local preference: 100, eBGP Protocol preference: 20, iBGP Protocol preference:
200
    Router ID: 198.51.100.102, Cluster ID: 198.51.100.102
  Capabilities
    Route refresh: True, AS4: True, Graceful restart: False, L2VPN EVPN:True L2VPN
VPLS:True
  Best route selection
    Always compare MED: False, Ignore as path: False
    Ignore local preference: False, Ignore origin: False
```

```
    Ignore MED: False, Ignore route source: False
    Ignore router ID: False, Ignore uptime: True
    Ignore cluster length: False, Ignore peer IP: False
    Route select parameter: 0
  Timers
    Connect retry: 30s, Keepalive: 30s, Holdtime: 90s
  Statistics
    Peers configured: 1, Peers auto discovery: 0
      Peers in idle          : 0
      Peers in connect       : 0
      Peers in active        : 0
      Peers in opensent      : 0
      Peers in openconfirm   : 0
      Peers in established   : 1
```

API To access the Operational State API that corresponds to this CLI, click here.

BGP Peer

The 'show bgp peer' commands display information on BGP peers.

Syntax:

show bgp peer <option> ...

Option	Description
-	Without any option, the commands display all BGP peers in all instances in a summary table format.
summary	Displays scaled BGP peer status.
detail	Detailed information on all BGP peers in all instances in a list view.
<peer-name>	Detailed information on the peer with the given name.
history	Displays BGP peer history information such as the peer state down reasons.
history <peer-address>	Displays BGP peer history information such as the peer state down reasons for a specified peer.
history <peer-address> detail`	Displays Detailed BGP peer history information such as the peer state down reasons for a specified peer.
history detail	Displays detailed BGP history information such as the peer state down reasons.

Option	Description
address <peer-address>	Detailed information on the peer with the given IP address.
instance <instance-name>	Summary of all BGP peers in the given instance.
instance <instance-name> detail	Detailed information on all BGP peers in the given instance.
instance <instance-name> detail <peer-name>	Detailed information on the peer with the given name in the given instance.
instance <instance-name> detail address <peer-address>	Detailed information on the peer with the given IP address in the given instance.
statistics	Received and sent BGP prefixes per AFI/SAFI for all peers in all instances.
statistics peer <peer-name>	Received and sent BGP prefixes per AFI/SAFI for the peer with the given name.
statistics peer address <peer-address>	Received and sent BGP prefixes per AFI/SAFI for the peer with the given IP address.
statistics instance <instance-name> peer <peer-name>	Received and sent BGP prefixes per AFI/SAFI for the peer with the given name in the given instance.
statistics instance <instance-name> peer address <peer-address>	Received and sent BGP prefixes per AFI/SAFI for the peer with the given IP address in the given instance.



Although 6PE routes are labeled, they are handled as unicast routes, and therefore will be shown as IPv6 unicast in the BGP peer statistics.

Example 1: BGP Peer Summary View

```
supervisor@rtbrick: op> show bgp peer
Instance: default
  Peer                                    Remote AS    State         Up/Down Time
PfxRcvd              PfxSent
  PE2                                     2000         Established
11d:22h:18m:30s            12                 20
Instance: default
  Peer                                    Remote AS    State         Up/Down Time
PfxRcvd              PfxSent
```

```
  CE1                                    65535        Established
6d:02h:28m:02s             2                    2
  CE1                                    65535        Established
6d:02h:27m:45s             2                    2
```

Example 2: BGP peer summary

```
supervisor@rtbrick.net: op> show bgp peer summary
Instance: default
 Established: 2, OpenConfirm: 0, OpenSent: 0, Active: 0, Connect: 0, Idle: 0
Instance: vrf1-blue
 Established: 0, OpenConfirm: 0, OpenSent: 0, Active: 0, Connect: 0, Idle: 0
Instance: vrf1-evpn-vpws
 Established: 0, OpenConfirm: 0, OpenSent: 0, Active: 0, Connect: 0, Idle: 0
Instance: vrf1-vpls-vpws
 Established: 0, OpenConfirm: 0, OpenSent: 0, Active: 0, Connect: 0, Idle: 0
```

Example 3: BGP Peer Detail View

```
supervisor@rtbrick.net cfg> show bgp peer detail
Peer: -, Peer IP: 12.0.0.1, Remote AS: -, Local IP: 12.0.0.2, Local AS:
4200000002, Any AS: False
  Type: ebgp, State: Idle, Up/Down Time: Thu Aug 07 05:57:40 GMT +0000 2025,
Reason: Cease, Sub-Code: Connect reject
  Discovered on interface: -
  Last transition: Thu Aug 07 17:19:19 GMT +0000 2025, Flap count: 1
  Peer ID        : 0.0.0.0, Local ID: 192.168.0.20
  Instance       : default, Peer group: PE1_PE2
  6PE enabled    : False
  TTL security   : False, TTL limit: -
  Timer values:
    Peer keepalive : 0s, Local keepalive: 30s
    Peer holddown  : 0s, Local holddown : 90s
    Connect retry  : 30s
  Timers:
    Connect retry timer : 0
    Keepalive timer     : 0
    Holddown timer      : 0
  NLRIs:
    Sent           : ['l2vpn-evpn', 'ipv4-unicast', 'ipv6-unicast', 'ipv4-vpn-
unicast', 'ipv6-vpn-unicast', 'ipv4-vpn-multicast', 'ipv4-labeled-unicast', 'ipv6-
labeled-unicast']
    Received       : ['l2vpn-evpn', 'ipv4-unicast', 'ipv6-unicast', 'ipv4-vpn-
unicast', 'ipv6-vpn-unicast', 'ipv4-vpn-multicast', 'ipv4-labeled-unicast', 'ipv6-
labeled-unicast']
    Negotiated     : ['l2vpn-evpn', 'ipv4-unicast', 'ipv6-unicast', 'ipv4-vpn-
unicast', 'ipv6-vpn-unicast', 'ipv4-vpn-multicast', 'ipv4-labeled-unicast', 'ipv6-
labeled-unicast']
  Capabilities:
    Addpath sent                  : None
    Addpath received              : None
    Addpath negotiated            : None
    Extended nexthop sent         : ['ipv4-vpn-unicast', 'ipv4-vpn-multicast']
    Extended nexthop received     : ['ipv4-vpn-multicast', 'ipv4-vpn-unicast']
    Extended nexthop negotiated   : ['ipv4-vpn-multicast', 'ipv4-vpn-unicast']
```

```
    <...>
```

Example 4: BGP Peer Statistics

```
supervisor@rtbrick: op> show bgp peer statistics instance default peer PE2
Instance: default
  Peer           AFI     SAFI               PfxRcvd    PfxSent
  PE2            ipv4    unicast            0          0
                 ipv4    labeled-unicast    0          0
                 ipv6    unicast            2          3
                 ipv6    labeled-unicast    2          3
                 ipv4    vpn-unicast        4          7
                 ipv6    vpn-unicast        4          7
                 ipv4    multicast          0          0
                 ipv4    vpn-multicast      0          0
```

Example 5: BGP Peer history for a specified peer

```
supervisor@rtbrick.net: op> show bgp peer history peer address 26.0.1.6
Instance: vrf1-blue
  Peer Address                              Source Address
Type         Last Reset Reason  Update Time
  26.0.1.6                                  26.0.1.2
TCP Error    Cease, Sub-Cod...  Sun Aug 10 13:12:21
  26.0.1.6                                  26.0.1.2
Config C...  Cease, Sub-Cod...  Sun Aug 10 13:12:04
```

Example 6: Detailed BGP peer history information

```
supervisor@rtbrick.net: op> show bgp peer history detail
Instance: vrf1-blue
  Peer address: 26.0.1.6, Source address: 26.0.1.2
    Type: TCP Error, Update time: Sun Aug 10 13:12:21 GMT +0000 2025,
    Last reset reason: Cease, Sub-Code: Admin shutdown
  Peer address: 26.0.1.6, Source address: 26.0.1.2
    Type: Config Change, Update time: Sun Aug 10 13:12:04 GMT +0000 2025,
    Last reset reason: Cease, Sub-Code: Admin shutdown
  <...>
```

API To access the Operational State API that corresponds to this CLI, click here.

BGP Peer Group

The 'show bgp peer-group' commands display parameters like BGP attributes that are specific to the respective peer groups.

Syntax:

show bgp peer-group <option> ...

Option	Description
-	Without any option, the commands display information on all peer groups in all instances.
<peer-group-name>	Information on the peer group with the given name.
instance <instance-name>	All peer groups in the given instance.
instance <instance-name> <peer-group-name>	Information on the peer group with the given name in the given instance.

Example 1: BGP Peer Group

```
supervisor@rtbrick: op> show bgp peer-group to_pe2
Instance: default
  Peer group name       : to_pe2
    Remote AS           : 2000
    Import rule         : None
    Export rule         : None
    Remove AS           : None
    Nexthop self        : None
    Multipath iBGP      : None
    Multipath eBGP      : None
    Client-to-Client    : None
    Add path            : None
    eBGP multihop       : None
    Hop (TTL)           : None
    Any AS              : None
    Update VPNv4 NH     : None
    Update MVPN NH      : None
```

Example 2: BGP peer group with TTL limit

```
supervisor@rtbrick.net: cfg> show bgp peer-group
Instance: default
  Peer group name: CE1
    Remote AS: 65034, EBGP multihop: 15
    Link-local next hop only: True, Local AS: 2
    RPKI validation filter: loose
  Peer group name: PE1
    Remote AS: 4200000001
    Local AS: 12, No prepend: True, Replace AS: True
    TTL security: True
```

Example 3: BGP peer group with EBGP multihop

```
supervisor@rtbrick.net: cfg> show bgp peer-group
Instance: default
  Peer group name: PE2
    Remote AS: 4200000002, EBGP multihop: 255
    Local AS: 4200000001, No prepend: True, Replace AS: True
```

BGP FIB

The show bgp fib commands display the BGP forwarding table. In contrast to the 'show bgp rib' commands, the output of the show bgp fib commands includes only the selected routes. The BGP route selection occurs between the RIB and the FIB.

Syntax:

show bgp fib <option> ...

Option	Description
-	Without any option, the commands display the BGP forwarding table for all address families and all instances in a summary table format.
instance	Instance name.
summary	Displays summary information.
<afi>	BGP forwarding table summary for the given address family (AFI), all sub-address families and all instances. Supported AFI values are 'ipv4' and 'ipv6'.
<afi> <safi>	BGP forwarding table summary for the given address family (AFI) and sub-address family (SAFI), and all instances. Supported SAFI values are 'unicast', 'labeled-unicast', 'multicast', 'vpn-multicast', and 'vpn-unicast'.
<afi> <safi> detail	Detailed list view of the BGP forwarding table for the given address family (AFI) and sub-address family (SAFI), and all instances.
<afi> <safi> <prefix>	BGP forwarding table entry for the given prefix and all instances.

Option	Description
<afi> <safi> instance <instance-name>	BGP forwarding table summary for the given AFI, SAFI, and instance.
<afi> <safi> instance <instance-name> detail	Detailed list view of BGP forwarding table for the given AFI, SAFI, and instance.
<afi> <safi> instance <instance-name> <prefix>	BGP forwarding table entry for the given prefix and instance.

Example 1: Summary information for the installed BGP routes in the FIB under a specific BGP instance.

```
supervisor@rtbrick.net: cfg> show bgp fib instance default summary
Instance: default, Total Routes: 1230200
  Address family                 Routes
  IPv4 unicast                  1000100
  IPv6 unicast                   230100
  Total Routes                  1230200
```

Example 2: Summary view of the BGP FIB for IPv6, all SAFIs and all instances

```
supervisor@rtbrick: op> show bgp fib ipv6
Instance: default, AFI: ipv6, SAFI: unicast
  Prefix                                    Preference      Out Label
Next Hop
  2001:db8:0:2::/32                         20              -
198.51.100.39
  2001:db8:0:2::/32                         20              -
198.51.100.39
Instance: services, AFI: ipv6, SAFI: unicast
  Prefix                                    Preference      Out Label
Next Hop
  2001:db8:0:6::/32                         200             -
2001:db8:0:4::
Instance: default, AFI: ipv6, SAFI: labeled-unicast
  Prefix                                    Preference      Out Label
Next Hop
  2001:db8:0:2::/32                         20              2003
198.51.100.39
  2001:db8:0:2::/32                         20              2003
198.51.100.39
Instance: default, AFI: ipv6, SAFI: vpn-unicast
  Prefix                                    Preference      Out Label
Next Hop
  2001:db8:0:5::/32                         200             20003,bos:1
  2001:db8:0:6::/32                         200             20003,bos:1
  2001:db8:0:8::/32                         200             20003,bos:1
  2001:db8:0:9::/32                         20              20006,bos:1
2001:db8:0:7::
  2001:db8:0:10::/32                        20              20006,bos:1
2001:db8:0:7::
```

```
  2001:db8:0:11::/32                          20              20006,bos:1
2001:db8:0:7::
  2001:db8:0:12::/32                          20              20006,bos:1
2001:db8:0:7::
```

Example 3: Detailed view of the BGP FIB for IPv6 VPN unicast routes in the default instances

```
supervisor@rtbrick: op> show bgp fib ipv6 vpn-unicast instance default detail
Instance: default, AFI: ipv6, SAFI: vpn-unicast
  Prefix: 2001:db8:0:5::/32
    Route source: bgp-local, Send path ID: 405188370, Received path ID: None, Path
hash: None
    AS path: None, Originator ID: None, Origin: Incomplete
    Community: None
    Extended community: ['target:198.51.100.93:2']
    Large community: None
    Cluster list: None
    IGP metric: None, Local preference: 100, Multi exit discriminator: 0
    Preference: 200, External route: None, Readvertised route: None
    Route up: None
    Next hop: 12.0.0.2, Label: 20003,bos:1
  Prefix: 2001:db8:0:6::/32
    Route source: bgp-local, Send path ID: 2400017309, Received path ID: None,
Path hash: None
    AS path: None, Originator ID: None, Origin: Incomplete
    Community: None
    Extended community: ['target:198.51.100.93:2']
    Large community: None
    Cluster list: None
    IGP metric: None, Local preference: 100, Multi exit discriminator: None
    Preference: 200, External route: None, Readvertised route: None
    Route up: None
    Next hop: 12.0.0.2, Label: 20003,bos:1
```

Example 4: Summary information for the installed BGP routes in the FIB under a specific BGP instance.

```
supervisor@rtbrick.net: cfg> show bgp fib instance default summary
Instance: default, Total Routes: 1230200
  Address family                Routes
  IPv4 unicast                 1000100
  IPv6 unicast                  230100
  Total Routes                 1230200
```

Example 5: Summary information for the installed BGP routes in the FIB for a specified AFI and SAFI within a specific BGP instance.

```
supervisor@rtbrick.net: cfg> show bgp fib ipv6 unicast summary
Instance: default, Total Routes: 230100
  Address family                Routes
  IPv6 unicast                  230100
```

```
  Total Routes                    230100
```

Example 5: Summary information for the installed BGP routes in the FIB.

```
supervisor@rtbrick.net: cfg> show bgp fib summary
Instance: default, Total Routes: 1230200
  Address family                  Routes
  IPv4 unicast                   1000100
  IPv6 unicast                    230100
  Total Routes                   1230200
```

BGP RIB-in

This command displays information about the BGP routes received from BGP neighbors.

Syntax:

show bgp rib-in <option>

Attribute	Description
-	Without any option, the command displays information on the received BGP routing table on all instances in a summary table format.
summary	Displays a summary of the RIB for all instances.
instance <instance-name>	Name of the instance. Displays the RIB summary information for BGP routes received from all neighbors for a specified instance. Additional filtering options such as detail, prefix, peer, peer address, and summary can be added to further narrow down the results.
instance <instance_name> peer address <peer_ip>	Displays the RIB entry for BGP routes learned from a specific peer IP address for a specified instance. Additional filtering options such as detail, summary can be used to further narrow down the results.

Attribute	Description
instance <instance_name> peer <peer-name>	Displays the RIB entry for BGP routes learned from a specific peer (name) for a specified instance. Additional filtering options such as detail, summary can be used to further narrow down the results.
instance <instance_name> <prefix>	Displays the RIB entry for a given prefix for a specified instance. Additional filtering options such as detail can be used to further narrow down the results.
instance <instance_name> summary	Displays a summary of the RIB for a specified instance.
<prefix>	Displays the RIB entry for a given prefix across all instances. Additional filtering options such as detail can be used to further narrow down the results.
<afi>	BGP routing table summary for the given address family (AFI), all sub-address families and all instances. Supported AFI values are 'ipv4' and 'ipv6'. Additional filtering options such as detail, flowspec, and instance can be added to further narrow down the results.
<afi> detail	Detailed list view of the BGP routing table for the given AFI,
<afi> flowspec	Displays BGP routing table entries for FlowSpec routes for the given AFI, all sub-address families and all instances. Supported AFI values are 'ipv4' and 'ipv6'. Additional filtering options such as community, detail, filter, hash, instance, peer address, peer, and summary can be added to further narrow down the results.
<afi> <prefix>	Displays the RIB entry for a given prefix for a specified address family. Supported AFI values are 'ipv4' and 'ipv6'. Additional filtering options such as detail can be added to further narrow down the results.

Attribute	Description
<afi> <safi>	Displays BGP routing table summary for the given AFI and subsequent address family identifier (SAFI), and all instances. Supported SAFI values are 'labeled-unicast', 'unicast', 'vpn-multicast', and 'vpn-unicast'. Additional filtering options such as community, detail, instance, peer address, peer, source, and summary can be added to further narrow down the results.
<afi> <safi> community <community>	Displays BGP routing table entries for a given community for the specified AFI and SAFI, and all instances. Additional filtering options such as detail can be added to further narrow down the results.
<afi> <safi> detail	Detailed list view of the BGP routing table for the given AFI and SAFI, and all instances. Supported SAFI values are 'labeled-unicast', 'unicast', 'vpn-multicast', and 'vpn-unicast'.
<afi> <safi> instance <instance_name>	BGP routing table summary for the given AFI, SAFI, and instance. Supported SAFI values are 'labeled-unicast', 'unicast', 'vpn-multicast', and 'vpn-unicast'. Additional filtering options such as detail, peer address, peer, prefix, and summary can be added to further narrow down the results.
<afi> <safi>source <source>	Displays a summarized list of all BGP routes received from a peer (source) for a specified AFI and SAFI. Supported AFI values are 'ipv4' and 'ipv6'. Additional filtering options such as detail can be added to further narrow down the results.
post-policy	Displays the post-policy RIB summary information for BGP routes received from all neighbors for all instances. Additional filtering options such as instance, import, prefix, source, summary, and validation-state can be added to further narrow down the results.
post-policy summary	Displays a summary of the post-policy RIB.

Attribute	Description
post-policy instance <instance-name>	Name of the instance. Displays the post-policy RIB summary information for BGP routes received from all neighbors for a specified instance. Additional filtering options such as detail, error, import, peer, peer address, policy-accept, policy-deny, summary, and validation-state can be added to further narrow down the results.
post-policy instance <instance-name> error	Displays the post-policy RIB entry for BGP routes that encountered errors during processing for a specified instance. Additional filtering options such as detail, nexthop-unreachable, and retain-rt-deny can be used to further narrow down the results.
post-policy instance <instance-name> import	Displays the post-policy RIB entry for BGP routes that were rejected by the import policy for a specified instance. Additional filtering options such as detail and summary can be used to further narrow down the results.
post-policy instance <instance-name> peer address <peer_ip>	Displays the post-policy RIB entry for BGP routes learned from a specific peer IP address for a specified instance. Additional filtering options such as detail, error, policy-accept, policy-deny, summary can be used to further narrow down the results.
post-policy instance <instance-name> peer <peer-name>	Displays the post-policy RIB entry for BGP routes learned from a specific peer (name) for a specified instance. Additional filtering options such as detail, error, policy-accept, policy-deny, summary can be used to further narrow down the results.
post-policy instance <instance-name> policy-accept	Displays the post-policy RIB entry for BGP routes that were accepted by the import policy for a specified instance. Additional filtering options such as detail can be used to further narrow down the results.
post-policy instance <instance-name> policy-deny	Displays the post-policy RIB entry for BGP routes that were denied by the import policy for a specified instance. Additional filtering options such as detail can be used to further narrow down the results.

Attribute	Description
post-policy instance <instance-name> <prefix>	Displays the post-policy RIB entry for a given prefix for a specified instance. Additional filtering options such as detail can be used to further narrow down the results.
post-policy instance <instance-name> summary	Displays a summary of the post-policy RIB for a specified instance.
post-policy instance <instance-name> validation-state <state>	Displays the post-policy RIB entry for BGP routes with a specific validation state for a specified instance. Supported validation states are unknown, valid, invalid, and init. Additional filtering options such as detail can be added to further narrow down the results.
post-policy <prefix>	Displays the post-policy RIB entry for a given prefix for all instances. Additional filtering options such as detail can be added to further narrow down the results.
post-policy <afi>	BGP routing table summary for the given AFI, all sub-address families and all instances. Supported AFI values are 'ipv4' and 'ipv6'. Additional filtering options such as detail, flowspec, and instance can be added to further narrow down the results.
post-policy <afi> detail	Detailed list view of the BGP routing table for the given AFI.
post-policy <afi> flowspec	Displays BGP routing table entries for FlowSpec routes for the given AFI, all sub-address families and all instances. Supported AFI values are 'ipv4' and 'ipv6'. Additional filtering options such as community, detail, error, filter, hash, import, instance, peer address, peer, policy-accept, policy-deny, and summary can be added to further narrow down the results.
post-policy <afi> <prefix>	Displays the post-policy RIB entry for a given prefix for a specified AFI. Supported AFI values are 'ipv4' and 'ipv6'. Additional filtering options such as detail can be added to further narrow down the results.

Attribute	Description
post-policy <afi> source <source>	Displays a summarized list of all BGP routes received from a peer (source) for a specified AFI. Supported AFI values are 'ipv4' and 'ipv6'. Additional filtering options such as detail can be added to further narrow down the results.
post-policy <afi> <safi>	Displays BGP routing table summary for the given AFI and SAFI, and all instances. Supported SAFI values are 'labeled-unicast', 'unicast', 'vpn-multicast', and 'vpn-unicast'. Additional filtering options such as community, detail, error, import, instance, peer address, peer, policy-accept, policy-deny can be added to further narrow down the results.
post-policy <afi> <safi> community <community>	Displays BGP routing table entries for a given community for the specified AFI and SAFI, and all instances. Additional filtering options such as detail can be added to further narrow down the results.
post-policy <afi> <safi> error	BGP routes with error status for the given AFI and SAFI, and all instances. Supported SAFI values are 'labeled-unicast', 'unicast', 'vpn-multicast', and 'vpn-unicast'. Additional filtering options such as detail, nexthop-unreachable, and retain-rt-deny can be used to further narrow down the results.
post-policy <afi> <safi> import	BGP routes that were rejected by the import policy for the given AFI and SAFI, and all instances. Supported SAFI values are 'labeled-unicast', 'unicast', 'vpn-multicast', and 'vpn-unicast'. Additional filtering options such as detail, summary and validation-state can be used to further narrow down the results.
post-policy <afi> <safi> detail	Detailed list view of the BGP routing table for the given AFI and SAFI, and all instances. Supported SAFI values are 'labeled-unicast', 'unicast', 'vpn-multicast', and 'vpn-unicast'.

Attribute	Description
post-policy <afi> <safi> instance <instance_name>	BGP routing table summary for the given AFI, SAFI, and instance. Supported SAFI values are 'labeled-unicast', 'unicast', 'vpn-multicast', and 'vpn-unicast'. Additional filtering options such as detail, error, import, peer address, peer, policy-accept, policy-deny, and summary can be added to further narrow down the results.

Example 1: Summary of the BGP received routes

```
supervisor@rtbrick.net: cfg> show bgp rib-in
Flags: & - Imported, ! - Error, N - RPKI Unknown, I - RPKI Invalid, V - RPKI Valid
Instance: default, AFI: ipv4, SAFI: unicast
  Hostname: Local, Peer IP: 0.0.0.0
  Source IP: 0.0.0.0, Total routes: 9
    Prefix                                  Next Hop        MED         Lpref
AS Path
    192.0.2.0/24                            -               0           -
-
    198.51.100.0/24                         -               0           -
-
    203.0.113.0/24                          -               0           -
-
    192.0.2.10/32                           -               0           -
-
    192.0.2.20/32                           -               0           -
-
    192.0.2.30/32                           -               0           -
-
    192.0.2.11/32                           -               0           -
-
    192.0.2.21/32                           -               0           -
-
    192.0.2.31/32                           -               0           -
-
Instance: default, AFI: ipv4, SAFI: unicast
  Hostname: PE1, Peer IP: 203.0.113.1
  Source IP: 203.0.113.2, Total routes: 4
    Prefix                                  Next Hop        MED         Lpref
AS Path
    198.51.100.10/32                        203.0.113.1     0           -
65536
    198.51.100.20/32                        203.0.113.1     0           -
65536
    198.51.100.11/32                        203.0.113.1     0           -
65536
    198.51.100.21/32                        203.0.113.1     0           -
65536
Instance: default, AFI: ipv4, SAFI: unicast
  Hostname: PE1, Peer IP: 2001:DB8::1
  Source IP: 2001:DB8::2, Total routes: 4
```

Example 2: The summary of all routes received from a specific BGP instance.

```
supervisor@rtbrick.net: cfg> show bgp rib-in summary
Instance: default, Total Routes: 124
  Hostname: Local, Peer IP: 0.0.0.0, Source IP: 0.0.0.0
    Address family                          Routes
    IPv4 unicast                            9
    IPv4 labeled-unicast                    9
    Total Routes                            18
  Hostname: PE1, Peer IP: 192.0.2.1, Source IP: 192.0.2.2
    Address family                          Routes
    IPv4 unicast                            4
    IPv4 labeled-unicast                    2
    IPv4 VPN-unicast                        6
    IPv4 VPN-multicast                      6
    IPv6 unicast                            4
    IPv6 labeled-unicast                    2
    IPv6 VPN-unicast                        6
    L2VPN VPLS                              7
    L2VPN EVPN                              7
    Total Routes                            44
  Hostname: Local, Peer IP: ::, Source IP: ::
    Address family                          Routes
    IPv6 unicast                            9
    IPv6 labeled-unicast                    9
    Total Routes                            18
  Hostname: PE1, Peer IP: 2001:DB8::1, Source IP: 2001:DB8::2
    Address family                          Routes
    IPv4 unicast                            4
    IPv4 labeled-unicast                    2
    IPv4 VPN-unicast                        6
    IPv4 VPN-multicast                      6
    IPv6 unicast                            4
    IPv6 labeled-unicast                    2
    IPv6 VPN-unicast                        6
    L2VPN VPLS                              7
    L2VPN EVPN                              7
    Total Routes                            44
    <...>
```

Example 3: View of BGP routes filtered based in the source protocol, direct.

```
supervisor@rtbrick.net: cfg> show bgp rib-in source direct
Flags: & - Imported, ! - Error, N - RPKI Unknown, I - RPKI Invalid, V - RPKI Valid
Instance: default, AFI: ipv4, SAFI: unicast
  Hostname: Local, Peer IP: 0.0.0.0
  Source IP: 0.0.0.0, Total routes: 9
    Prefix                                  Next Hop        MED         Lpref
AS Path
    192.0.2.0/24                            -               0           -
-
    192.0.2.1/24                            -               0           -
-
    192.0.2.2/24                            -               0           -
-
    192.168.0.20/32                         -               0           -
-
```

```
    192.168.1.20/32                          -               0           -
-
    192.168.2.20/32                          -               0           -
-
    192.168.0.21/32                          -               0           -
-
    192.168.1.21/32                          -               0           -
-
    192.168.2.21/32                          -               0           -
-
Instance: vrf1-blue, AFI: ipv4, SAFI: unicast
  Hostname: Local, Peer IP: 0.0.0.0
  Source IP: 0.0.0.0, Total routes: 4
    Prefix                                  Next Hop        MED         Lpref
AS Path
```

Example 4: Summary view of the BGP rib-in for IPv4, all SAFIs and all instances

```
supervisor@rtbrick: op> show bgp rib-in ipv4
Flags: & - Imported, ! - Error, N - RPKI Unknown, I - RPKI Invalid, V - RPKI Valid
Instance: default, AFI: ipv4, SAFI: unicast
  Hostname: Local, Peer IP: 0.0.0.0
  Source IP: 0.0.0.0, Total routes: 9
    Prefix                                  Next Hop        MED         Lpref       AS Path
    192.0.2.0/24                            -               0           -           -
    192.0.2.1/24                            -               0           -           -
    192.0.2.2/24                            -               0           -           -
    192.0.2.20/32                           -               0           -           -
    192.0.2.21/32                           -               0           -           -
    192.0.2.22/32                           -               0           -           -
    192.0.2.23/32                           -               0           -           -
    192.0.2.24/32                           -               0           -           -
    192.0.2.25/32                           -               0           -           -
Instance: default, AFI: ipv4, SAFI: unicast
  Hostname: PE1, Peer IP: 192.0.2.1
  Source IP: 192.0.2.2, Total routes: 4
    Prefix                                  Next Hop        MED         Lpref       AS Path
    192.0.2.10/32                           192.0.2.1       0           -           65536
    192.0.2.11/32                           192.0.2.1       0           -           65536
    192.0.2.12/32                           192.0.2.1       0           -           65536
    192.0.2.13/32                           192.0.2.1       0           -           65536
Instance: default, AFI: ipv4, SAFI: unicast
  Hostname: PE1, Peer IP: 192::1
  Source IP: 192::2, Total routes: 4
    Prefix                                  Next Hop        MED         Lpref       AS Path
    192.0.2.10/32                           192::1          0           -           65536
    192.0.2.11/32                           192::1          0           -           65536
    192.0.2.12/32                           192::1          0           -           65536
    192.0.2.13/32                           192::1          0           -           65536
```

Example 5: Summary view of the received routes

```
supervisor@rtbrick: op> show bgp rib-in ipv4 unicast instance default peer address 192.0.2.1
Flags: & - Imported, ! - Error, N - RPKI Unknown, I - RPKI Invalid, V - RPKI Valid
Instance: default, AFI: ipv4, SAFI: unicast
  Hostname: PE1, Peer IP: 192.0.2.1
  Source IP: 192.0.2.2, Total routes: 4
    Prefix                          Next Hop            MED         Lpref       AS Path
    192.168.1.10/32                 192.0.2.1           0           -           65536
    192.168.2.10/32                 192.0.2.1           0           -           65536
    192.168.1.11/32                 192.0.2.1           0           -           65536
```

```
    192.168.2.11/32                192.0.2.1            0          -          65536
```

Example 6: Summary view of the BGP rib-in post-policy

```
supervisor@rtbrick.net: op> show bgp rib-in post-policy
Flags: & - Imported, ! - Error, N - RPKI Unknown, I - RPKI Invalid, V - RPKI Valid
Instance: default, AFI: ipv4, SAFI: unicast
  Hostname: Local, Peer IP: 0.0.0.0
  Source IP: 0.0.0.0, Total routes: 9
    Flags  Prefix                                Next Hop          MED
Lpref       AS Path
           192.0.2.0/24                          -                 0           -
-
           192.0.2.1/24                          -                 0           -
-
           192.0.2.2/24                          -                 0           -
-
           203.0.113.20/32                       -                 0           -
-
           203.0.113.21/32                       -                 0           -
-
           203.0.113.22/32                       -                 0           -
-
           203.0.113.23/32                       -                 0           -
-
           203.0.113.24/32                       -                 0           -
-
           203.0.113.25/32                       -                 0           -
-
Instance: default, AFI: ipv4, SAFI: unicast
  Hostname: PE1, Peer IP: 192.0.2.1
  Source IP: 192.0.2.2, Total routes: 3
    Flags  Prefix                                Next Hop          MED
Lpref       AS Path
           192.0.2.10/32                         192.0.2.1         0           -
65536
           192.0.2.11/32                         192.0.2.1         0           -
65536
           192.0.2.12/32                         192.0.2.1         0           -
65536
Instance: default, AFI: ipv4, SAFI: unicast
  Hostname: PE1, Peer IP: 2001:DB8::1
  Source IP: 2001:DB8::2, Total routes: 3
    Flags  Prefix                                Next Hop          MED
Lpref       AS Path
           192.0.2.10/32                         2001:DB8::1       0           -
65536
           192.0.2.11/32                         2001:DB8::1       0           -
65536
           192.0.2.12/32                         2001:DB8::1       0           -
65536
Instance: vrf1-blue, AFI: ipv4, SAFI: unicast
  Hostname: Local, Peer IP: 0.0.0.0
  Source IP: 0.0.0.0, Total routes: 5
    Flags  Prefix                                Next Hop          MED
Lpref       AS Path
           0.0.0.0/0                             -                 0           -
-
           192.0.2.30/24                         -                 0           -
```

```
-
           192.0.2.31/32                          -                0           -
-
           192.0.2.32/32                          -                0           -
-
           192.0.2.33/32                          -                0           -
-
```

Example 7: Summary view of the BGP rib-in post-policy for a specific instance, AFI, and SAFI.

```
supervisor@rtbrick.net: op> show bgp rib-in post-policy ipv4 unicast instance
default
Flags: & - Imported, ! - Error, N - RPKI Unknown, I - RPKI Invalid, V - RPKI Valid
Instance: default, AFI: ipv4, SAFI: unicast
  Hostname: Local, Peer IP: 0.0.0.0
  Source IP: 0.0.0.0, Total routes: 9
    Flags  Prefix                                Next Hop            MED
Lpref       AS Path
           192.0.2.0/24                           -                0           -
-
           192.0.2.1/24                           -                0           -
-
           192.0.2.2/24                           -                0           -
-
           192.0.2.3/32                           -                0           -
-
           192.0.2.4/32                           -                0           -
-
           192.0.2.5/32                           -                0           -
-
           192.0.2.6/32                           -                0           -
-
           192.0.2.7/32                           -                0           -
-
           192.0.2.8/32                           -                0           -
-
Instance: default, AFI: ipv4, SAFI: unicast
  Hostname: PE1, Peer IP: 192.0.2.9
  Source IP: 192.0.2.10, Total routes: 3
    Flags  Prefix                                Next Hop            MED
Lpref       AS Path
           192.0.2.11/32                          192.0.2.9        0           -
65536
           192.0.2.12/32                          192.0.2.9        0           -
65536
           192.0.2.13/32                          192.0.2.9        0           -
65536
Instance: default, AFI: ipv4, SAFI: unicast
  Hostname: PE1, Peer IP: 192.0.2.14
  Source IP: 192.0.2.15, Total routes: 3
    Flags  Prefix                                Next Hop            MED
Lpref       AS Path
           192.0.2.11/32                          192.0.2.14       0           -
65536
           192.0.2.12/32                          192.0.2.14       0           -
65536
           192.0.2.13/32                          192.0.2.14       0           -
```

```
65536
```

Example 8: Summary view of the BGP rib-in post-policy for a specific instance, AFI, SAFI, and policy-accept filter.

```
supervisor@rtbrick.net: op> show bgp rib-in post-policy ipv4 unicast policy-accept
Flags: & - Imported, ! - Error, N - RPKI Unknown, I - RPKI Invalid, V - RPKI Valid
Instance: default, AFI: ipv4, SAFI: unicast
  Hostname: PE1, Peer IP: 192.0.2.1
  Source IP: 192.0.2.2, Total routes: 3
    Flags  Prefix                              Next Hop           MED
Lpref       AS Path
           192.168.1.10/32                     192.0.2.1          0           -
65536
           192.168.2.10/32                     192.0.2.1          0           -
65536
           192.168.1.11/32                     192.0.2.1          0           -
65536
Instance: default, AFI: ipv4, SAFI: unicast
  Hostname: PE1, Peer IP: 192::1
  Source IP: 192::2, Total routes: 3
    Flags  Prefix                              Next Hop           MED
Lpref       AS Path
           192.168.1.10/32                     192::1             0           -
65536
           192.168.2.10/32                     192::1             0           -
65536
           192.168.1.11/32                     192::1             0           -
65536
```

Example 9: Summary view of the BGP rib-in post-policy for a specific instance, AFI, SAFI, and policy-deny filter.

```
supervisor@rtbrick.net: op> show bgp rib-in post-policy ipv4 unicast policy-deny
Flags: & - Imported, ! - Error, N - RPKI Unknown, I - RPKI Invalid, V - RPKI Valid
Instance: default, AFI: ipv4, SAFI: unicast
  Hostname: PE1, Peer IP: 192.0.2.1
  Source IP: 192.0.2.2, Total routes: 1
    Flags  Prefix                              Next Hop               MED
Lpref       AS Path
    !      192.168.2.11/32                     192.0.2.1              0
-           65536
Instance: default, AFI: ipv4, SAFI: unicast
  Hostname: PE1, Peer IP: 192::1
  Source IP: 192::2, Total routes: 1
    Flags  Prefix                              Next Hop               MED
Lpref       AS Path
    !      192.168.2.11/32                     192::1                 0
-           65536
```

Example 10: Summary view of the BGP rib-in post-policy for a specific instance, AFI, SAFI, and peer address filter.

```
supervisor@rtbrick.net: op> show bgp rib-in post-policy ipv4 unicast peer address
192.0.2.1
Flags: & - Imported, ! - Error, N - RPKI Unknown, I - RPKI Invalid, V - RPKI Valid
Instance: default, AFI: ipv4, SAFI: unicast
  Hostname: PE1, Peer IP: 192.0.2.1
  Source IP: 192.0.2.2, Total routes: 3
    Flags  Prefix                            Next Hop              MED
Lpref       AS Path
           192.0.2.10/32                     192.0.2.1             0           -
65536
           192.0.2.20/32                     192.0.2.1             0           -
65536
           192.0.2.11/32                     192.0.2.1             0           -
65536
```

Example 11: Summary view of the BGP rib-in post-policy for a specific instance, AFI, SAFI, and validation-state filter.

```
supervisor@rtbrick.net: op> show bgp rib-in post-policy ipv4 unicast validation-
state init
Flags: & - Imported, ! - Error, N - RPKI Unknown, I - RPKI Invalid, V - RPKI Valid
Instance: default, AFI: ipv4, SAFI: unicast
  Hostname: PE1, Peer IP: 192.0.2.1
  Source IP: 192.0.2.2
    Flags  Prefix                                Next Hop           MED
Lpref       AS Path
           192.0.2.10/32                         192.0.2.1          0           -
65536
           192.0.2.20/32                         192.0.2.1          0           -
65536
           192.0.2.11/32                         192.0.2.1          0           -
65536
Instance: default, AFI: ipv4, SAFI: unicast
  Hostname: PE1, Peer IP: 192::1
  Source IP: 192::2
    Flags  Prefix                                Next Hop           MED
Lpref       AS Path
           192.0.2.10/32                         192::1             0           -
65536
           192.0.2.20/32                         192::1             0           -
65536
           192.0.2.11/32                         192::1             0           -
65536
```

BGP RIB-out

This command displays the send routes.

Syntax:

show bgp rib-out <option> ...

Option	Description
-	Without any option, the command displays advertised BGP routes for all instances.
<afi>	BGP routing table summary for the given address family (AFI), all sub-address families and all instances. Supported AFI values are 'ipv4' and 'ipv6'.
<afi> <safi>	BGP routing table summary for the given address family (AFI) and sub-address family (SAFI), and all instances. Supported SAFI values are evpn, evpn-vpws, flowspec, labeled-unicast, multicast, unicast, vpls, vpls-vpws, vpn-multicast, and vpn-unicast.
<afi> <safi> detail	Detailed list view of the BGP routing table for the given address family (AFI) and sub-address family (SAFI), and all instances.
<afi> <safi> <prefix>	BGP routing table entry for the given prefix and all instances.
<afi> <safi> instance <instance-name>	BGP routing table summary for the given AFI, SAFI, and instance.
<afi> <safi> instance <instance-name> detail	Detailed list view of BGP routing table for the given AFI, SAFI, and instance.
<afi> <safi> peer address <peer-ip>	View of BGP routing table for the given peer Ip address.
<afi> <safi> peer address <peer-ip> detail	Detailed list view of BGP routes for give peer IP address.
<afi> <safi> peer <peer-name>	Displays BGP routing table for the given peer.
<afi> <safi> peer <peer-name>	Detailed list view of BGP routes for the given peer IP address.
<afi> <safi> peer-group <name>	Information of BGP routes for the given peer group name.
<afi> <safi> community <community-name>	Displays BGP routing table for the given community.
<afi> <safi> community <community-name> detail	Detailed list view of BGP routing table for the given community.

Option	Description
<afi> <safi> instance <instance-name> <prefix>	BGP routing table entry for the given prefix and instance.
<afi> <safi> peer <name> / peer address <ip>	Peer name or address

Example 1: Summary view of the routes advertised to a peer

```
supervisor@rtbrick.net: cfg> sho bgp rib-out ipv4 unicast peer PE2_HOST
Instance: default, AFI: ipv4, SAFI: unicast
  Peer: PE2_HOST, Peer IP: 12.0.0.2, Sent routes: 4
    Prefix                                  MED     Lpref      Origin          Next Hop
AS Path
    192.168.1.10/32                         -       100        Incomplete      -
-
    192.168.2.10/32                         -       100        Incomplete      -
-
    192.168.1.11/32                         -       100        Incomplete      -
-
    192.168.2.11/32                         -       100        Incomplete      -
-
```

Example 2: Detailed view of the routes advertised to a peer

```
supervisor@rtbrick: op> show bgp rib-out
Instance: vrf1, AFI: ipv4, SAFI: unicast
  Peer-group: pe1_ce1, Sent routes: 4
    Prefix                              MED             Lpref             Origin
Next Hop                            AS Path
    198.51.100.104/24                   0               -
Incomplete      -                                   65001
    198.51.100.113/24                   0               -
Incomplete      -                                   65001
    198.51.100.105/24                   0               -
Incomplete      -                                   65001
    198.51.100.106/24                   0               -
Incomplete      -                                   65001
Instance: vrf1, AFI: ipv6, SAFI: unicast
  Peer-group: pe1_ce1, Sent routes: 3
    Prefix                              MED             Lpref             Origin
Next Hop                            AS Path
    2001:db8:0:14::/24                  0               -
Incomplete      -                                   65001
    2001:db8:0:15::/24                  0               -
Incomplete      -                                   65001
    2001:db8:0:16::/24                  0               -
Incomplete      -                                   65001
```

Example 3: Routes advertised to a peer

```
supervisor@rtbrick.net: cfg> show bgp fib ipv4 multicast
Instance: vrf1-blue, AFI: ipv4, SAFI: multicast
  Group           Source                                      Preference
```

```
Out Label            Route Type           Next Hop
  -                -                                        20
20002,bos:1          Intra-AS_I-PMSI_AD   12.0.0.1

20002,bos:1          Intra-AS_I-PMSI_AD   12::1
  232.1.1.1/32     10.1.1.1/32                              20
20002,bos:1          Source_Tree_Join     12.0.0.1

20002,bos:1          Source_Tree_Join     12::1
  232.1.2.1/32     10.1.1.1/32                              20
20002,bos:1          Source_Tree_Join     12.0.0.1

20002,bos:1          Source_Tree_Join     12::1
```

TCP Connections

This command displays information of the TCP connections used by BGP.

Syntax:

show bgp tcp bgp.iod.1 connection <option> ...

Option	Description
-	Without any option, the command displays the TCP connections used by BGP for all instances.
detail	Detailed list view of the the TCP connections for the given address family (AFI) and sub-address family (SAFI), and all instances.
prefix	TCP connections for the given prefix and all instances.
instance <instance-name>	TCP connections summary for the given instance.

Example 1: Summary view of the BGP TCP connections

```
supervisor@leaf1: cfg> show bgp tcp bgp.iod.1 connection
Instance       Local IP Address                 Remote IP Address          Local
Port  Remote Port  State
default          2001:db8:0:189::               2001:db8:0:38::            179
49568        Established
default          2001:db8:0:61::                2001:db8:0:237::           50529
179          Established
```

Example 2: Detailed information of the BGP TCP connections

```
supervisor@leaf1: cfg> show bgp tcp bgp.iod.1 connection detail
Instance: default
  Local IPv6 address       : 2001:db8:0:189::
  Remote IPv6 address      : 2001:db8:0:38::
  Local port               : 179
  Remote port              : 49568
  State                    : Established
    Internal
      Options                  : -- | Keepalive | --
      TOS                      : 0
      TTL                      : 1
      Priority                 : 1
      Flags                    : -|-|-|-|-|Nagle Disabled|-|Wnd Scale|-|-|-
      Last trigger             : 27
      Timer                    : 37624
    Timers
      Poll                     : 0s
      Poll interval            : 0s
      Retransmission           : 65535s
    Receiver
      Expected sequence        : 32965979
      Available window         : 96816
      Announced window         : 95562
      Announced wnd RT edge    : 33061541
      MSS                      : 1440
      RTT estimate             : 0
    Timeout
      Sequence                 : 17683639s
      Retransmission           : 3s
      Retransmissions          : 0s
      Duplicate acks           : 0s
      Highest ack'd sequence   : 17683658s
    Congestion
      Window                   : 162834
      Persist count            : 0
      Send scale               : 5
      Receive scale            : 5
    Sender
      Next seq to send         : 17683658
      Last wnd update seq      : 32965979
      Last wnd update ack      : 17683658
      Window                   : 96192
      Max window announced     : 96800
      Acknowledged             : None
      Send buf                 : 56476
      Send queue length        : 0
      Unsent oversize          : 0
      TS last ack sent         : 818020352
    Keepalive
      Next keepalive idle      : 7200000
      Keepalive interval       : 75000
      Keepalive count          : 9
      Keep sent count          : 0
    Authentication
      Auth type                : HMAC-SHA-256-128
      key1-id                  : 255
      key2-id                  : 0
      Algorithm mismatch       : 0
      Secret mismatch          : 43
      Latest sent digest       : 850fea02c98912ce4497ec2b101a4f7c
```

```
      Latest received digest   : a718fb88e0d7fd4a00843e6aec03c864
```

TCP Statistics

This command displays TCP statistics information of the TCP connections used by BGP.

Syntax:

show bgp tcp bgp.iod.1 statistics <option> ...

Option	Description
-	Without any option, the command displays the TCP statistics information of the TCP connections used by BGP for all instances.
instance <instance-name>	TCP connections summary for the given instance.

Example: TCP statistics information of the TCP connections used by BGP for the default instance

```
supervisor@rtbrick: op> show bgp tcp bgp.iod.1 statistics instance default
Instance: default
  IP statistics
    Transmitted packets    : 3103242412
    Received packets       : 47351
    Forwarded packets      : 0
    Dropped packets        : 0
    Checksum error         : 0
    Invalid length error   : 0
    Out of memory error    : 0
    Routing error          : 0
    Protocol error         : 0
    Error in options       : 0
    Misc error             : 0
    Cachehit               : 0
  TCP statistics
    Transmitted packets    : 365499779
    Received packets       : 5577
    Forwarded packets      : 3014656
    Dropped packets        : 46
    Checksum error         : 0
    Invalid length error   : 0
    Out of memory error    : 0
    Routing error          : 3014656
    Protocol error         : 46
    Error in options       : 0
    Misc error             : 2097152
```

```
    Cachehit                : 1557594144
```

BGP Clear Commands

Clear commands allow to reset operational states.

BGP Peer

This commands resets BGP peerings.

Syntax:

clear bgp peer <option> ...

Option	Description
all	Clears all the BGP peers.
all soft-in <afi> <safi>	Sends route refresh to all neighbors.
all soft-out <afi> <safi>	Re-advertises all the routes previously sent to the peer.
all stats	Clears the statistics of all the BGP peers.
instance <instance> <peer-ip>	Clears the peer for the given instance and peer IP address.
instance <instance> <peer-ip> source <src-ip>	Clears a specific peer for the given peer IP address and source IP address in the specified instance.
instance <instance> all	Clears all peers in the given instance.
instance <instance> <peer-ip> source <src-ip> soft-in <afi> <safi>	Sends route refresh to specific peer for the given instance, peer-ip, source-ip and address-family.
instance <instance> <peer-ip> soft-in <afi> <safi>	Sends route refresh to peer for the given instance, peer-ip and address-family.
instance <instance> all soft-in <afi> <safi>	Sends route refresh to all peers for the given instance and address family.

Option	Description
instance <instance> <peer-ip> source <src-ip> soft-out <afi> <safi>	Re-advertises all the routes previously sent to the specific peer for the given instance, peer-ip, source-ip and address-family.
instance <instance> <peer-ip> soft-out <afi> <safi>	Sends route refresh to peer for a given instance, peer-ip and address-family.
instance <instance> all soft-out <afi> <safi>	Sends route update to all peers for given instance and address family.
instance <instance> <peer-ip> source <src-ip> stats	Clears the statistics of a specific peer for a given instance, peer-ip and source-IP.
instance <instance> <peer-ip> stats	Clears the statistics of the peer for a given instance and peer-IP.
instance <instance> all stats	Clears the statistics of all peers for a given instance.

Example: The example below shows how to clear all the BGP peers.

```
supervisor@rtbrick: op> clear bgp peer all
```

API To access the Operational State API that corresponds to this CLI, click here.

2.4. BGP FlowSpec

2.4.1. BGP FlowSpec Overview

BGP FlowSpec is an extension of the BGP protocol that allows for the dynamic propagation of more specific information than the traffic aggregate defined by an IP Prefix. This enables network administrators to control data traffic flow at any point in their network infrastructure. BGP FlowSpec can be used for various purposes, such as managing congestion or mitigating distributed denial-of-service (DDoS) attacks. Expanding routing information with FlowSpec allows the routing system to use the ACL (Access Control List) or firewall capabilities in the router's forwarding path.

The figure below shows a traffic scrubbing station capable of generating the

FlowSpec rule in the event of a DDoS attack and sending the BGP FlowSpec update to the neighbouring devices. The device that can interpret this update can drop the DDoS traffic as it arrives.

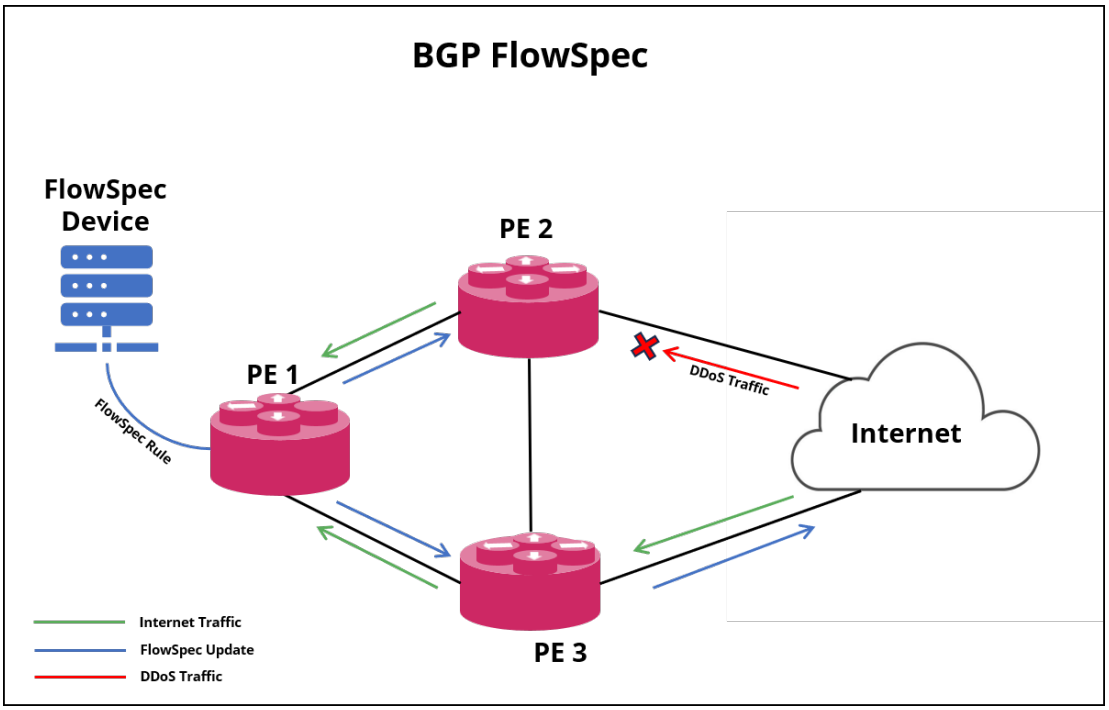


Figure 8. BGP FlowSpec Overview

FlowSpec helps to establish matching criteria for IP traffic packets encoded into BGP Network Layer Reachability Information (NLRI). The requirements can include various attributes and may or may not involve reachability information. Routers can use FlowSpec to forward, shape, classify, rate limit, filter, or redirect packets based on specific policies, allowing for rules that operate on multiple fields of the packet header.

The figure below shows the high-level flow of BGP FlowSpec design.

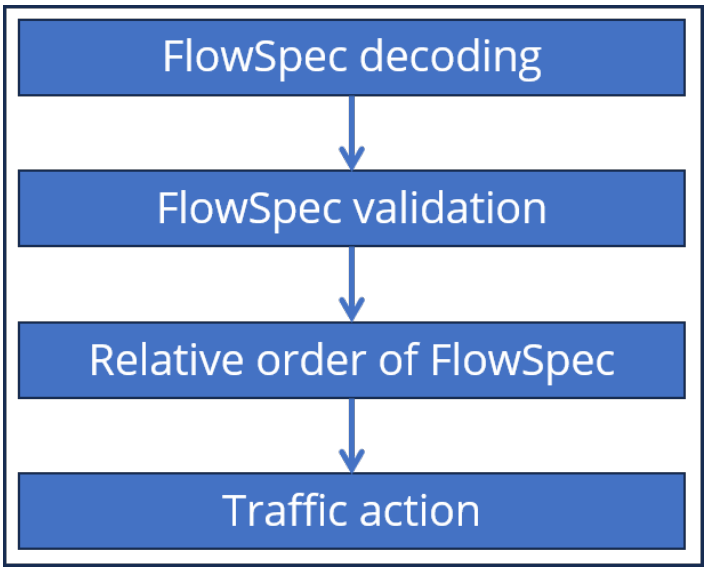


Figure 9. High-level flow of BGP FlowSpec design

FlowSpec involves actively processing and inserting dynamic ACLs in an operational environment. When a router receives a FlowSpec update, it can dynamically create IP filters to mitigate intra-AS and inter-AS DDoS attacks and other unwanted traffic patterns. Mitigation is implemented by dropping or rate-limiting the traffic at the network's ingress point (or the nearest possible point toward the source of the DDoS attack).

Matching of TCP flags is enabled in BGP FlowSpec.

Supported BGP Standards

RFC Number	Description
RFC 8955	Dissemination of Flow Specification Rules for IPv4
RFC 8956	Dissemination of Flow Specification Rules for IPv6

RFC and draft compliance are partial except as specified.

Supported Platforms

Not all features are necessarily supported on each hardware platform. Refer to the *Platform Guide* for the features and the sub-features that are or are not supported by each platform.

Supported Matching Criteria and Actions

The tables below outline the FlowSpec supported matching criteria and actions.

BGP FlowSpec NLRI Type	Match Criteria & Description		Option	Supported (Yes/No)
Type 1	Destination-Prefix (ipv4/ipv6)	Defines the destination prefix to match	specific host	Yes
			IP range	Yes
Type 2	Source-Prefix (ipv4/ipv6)	Defines the source prefix to match.	specific host	Yes
			IP range	Yes
Type 3	IP-Protocol	Contains a set of {operator, value} pairs that match the IP protocol value byte in IP packets.	specific value	Yes
			multi-value range	No
Type 4	Port (src or dst)	Defines a list of {operator, value} pairs that match source or destination ports.	specific value	No
			multi-value range	No
Type 5	Destination port	Defines a list of {operator, value} pairs used to match the destination port of a TCP or UDP packet.	specific value	Yes
			multi-value range	No
Type 6	Source port	Defines a list of {operator, value} pairs used to match the source port of a TCP or UDP packet.	specific value	Yes
			multi-value range	No

BGP FlowSpec NLRI Type	Match Criteria & Description		Option	Supported (Yes/No)
Type 7	ICMP type	Defines a list of {operator, value} pairs used to match the type field of an ICMP packet	specific value	No
			multi-value range	No
Type 8	ICMP code	Defines a list of {operator, value} pairs used to match the code field of an ICMP packet.	specific value	No
			multi-value range	No
Type 9	TCP flag	IPv4 or IPv6 TCP flags(2 bytes include reserved bits)	specific value	Yes
			multi-value range	Yes
Type 10	Packet length	Match on the total IP packet length	specific value	No
			multi-value range	No
Type 11	DSCP	Defines a list of {operator, value} pairs that use a Multi-value range to match the 6-bit DSCP field.	specific value	No
			multi-value range	No
Type 12	Fragment	Identifies a fragment-type as the match Bit mask criterion for a class map.	specific value	No
			multi-value range	No



The maximum number of matches supported in a single FlowSpec rule is 8.

The table below outlines the supported actions for BGP FlowSpec rules.

	Action Criteria & Description		Option	Supported (Yes/No)
1	traffic-rate-bytes	Traffic-rate limits specified in bytes per second	0 (drop)	Yes
			>0	Yes
2	traffic-rate-packets	Traffic-rate limits specified in packets per second	0 (drop)	Yes
			>0	No
3	traffic-action	Action that is performed on the traffic that matches FlowSpec rule	Terminal	No
			Sampling	No
4	rt-redirect	Redirects the traffic to a specific VRF instance or to a next-hop	to vrf	No
			to nexthop	No



The user-defined ACL priority range is 100 to 20000, while BGP FlowSpec priority ranges from 1501 to 2500, which prevents conflicts during configuration.

Operators Supported in Matching Criteria and Actions

Operator Type	Supported Operators	Unsupported Operators
Relational	equal	greater than, greater than or equal, less than, less than or equal, not equal

Operator Type	Supported Operators	Unsupported Operators
Logical	or	and

2.4.2. BGP FlowSpec Configuration

Enabling BGP FlowSpec Address Family

Adding the FlowSpec address family to the BGP address-family configuration enables the exchange of BGP FlowSpec NLRIs.

Syntax:

set <instance> <instance-name> protocol bgp address-family <afi> <safi>

Attribute	Description
<instance-name>	Name of the BGP instance
<afi>	Address family identifier (AFI). Supported values: ipv4, ipv6
<safi>	Subsequent address family identifier (SAFI). Specify "flowspec" as the SAFI for BGP to enable the exchange of BGP FlowSpec NLRIs.

Example 1: BGP FlowSpec IPv4 Configuration

```
supervisor@rtbrick>LEAF01: cfg> show config instance default protocol bgp address-
family ipv4 flowspec
{
  "rtbrick-config:address-family": [
    {
      "afi": "ipv4",
      "safi": "flowspec"
    }
  ]
}
```

Example 2: BGP FlowSpec IPv6 Configuration

```
supervisor@rtbrick>LEAF01: cfg> show config instance default protocol bgp address-
family ipv6 flowspec
{
  "rtbrick-config:address-family": [
```

```
    {
      "afi": "ipv6",
      "safi": "flowspec"
    }
  ]
}
```

Enabling BGP FlowSpec in Peer Group Address Family

Syntax:

set instance <instance-name> **protocol bgp peer-group** <peer-group-name> **address-family** <afi> <safi> <attribute> <value>

Attribute	Description
<afi>	Address family identifier (AFI). Supported values: ipv4, ipv6, l2vpn
<safi>	Subsequent address family identifier (SAFI). Specify "flowspec" as the SAFI to enable BGP FlowSpec in Peer Group address family.

Example 1: BGP FlowSpec in Peer Group Address Family

```
supervisor@rtbrick>LEAF01: cfg> show config instance default protocol bgp peer-
group
{
  "rtbrick-config:peer-group": [
    {
      "pg-name": "PE2",
      "remote-as": 4200000002,
      "address-family": [
        {
          "afi": "ipv4",
          "safi": "flowspec"
        },
        {
          "afi": "ipv4",
          "safi": "unicast"
        },
        {
          "afi": "ipv6",
          "safi": "flowspec"
        },
        {
          "afi": "ipv6",
          "safi": "unicast"
        }
      ]
```

```
    }
  ]
}
```

2.4.3. BGP FlowSpec Operational Commands

BGP Show Commands

show bgp peer

The 'show bgp peer' commands display information on BGP peers.

Syntax:

show bgp peer <option> ...

Option	Description
-	Without any option, the commands display all BGP peers in all instances in a summary table format.
detail	Detailed information on all BGP peers in all instances in a list view.
<peer-name>	Detailed information on the peer with the given name.
history	Displays BGP peer history information such as the peer state down reasons.
history <peer-address>	Displays BGP peer history information such as the peer state down reasons for a specified peer.
address <peer-address>	Detailed information on the peer with the given IP address.
instance <instance-name>	Summary of all BGP peers in the given instance.
instance <instance-name> detail	Detailed information on all BGP peers in the given instance.
instance <instance-name> detail <peer-name>	Detailed information on the peer with the given name in the given instance.

Option	Description
instance <instance-name> detail address <peer-address>	Detailed information on the peer with the given IP address in the given instance.
statistics	Received and sent BGP prefixes per AFI/SAFI for all peers in all instances.
statistics peer <peer-name>	Received and sent BGP prefixes per AFI/SAFI for the peer with the given name.
statistics peer address <peer-address>	Received and sent BGP prefixes per AFI/SAFI for the peer with the given IP address.
statistics instance <instance-name> peer <peer-name>	Received and sent BGP prefixes per AFI/SAFI for the peer with the given name in the given instance.
statistics instance <instance-name> peer address <peer-address>	Received and sent BGP prefixes per AFI/SAFI for the peer with the given IP address in the given instance

Example 1: BGP Peer Summary View

```
supervisor@rtbrick>LEAF01: op> show bgp peer
Instance: default
  Peer         Remote AS    State         Up/Down Time    PfxRcvd   PfxSent
  PE2          4200000002   Established   0d:01h:35m:53s  42        72
  99.1.1.2     65002        Established   0d:01h:35m:53s  2         27
```

Example 2: BGP Peer Detail View

```
supervisor@rtbrick>LEAF01: op> show bgp peer detail
Peer: PE2, Peer IP: 12.0.0.2, Remote AS: 4200000002, Local: 12.0.0.1, Local AS:
4200000001, Any AS: False
  Type: ebgp, State: Established, Up/Down Time: 0d:01h:38m:59s, Reason: Cease,
Sub-Code: Admin reset
  Discovered on interface: -
  Last transition: Thu Jun 20 09:35:06 GMT +0000 2024, Flap count: 1
  Peer ID        : 192.168.0.20, Local ID  : 192.168.0.10
  Instance       : default, Peer group: PE2
  6PE enabled    : False
  Timer values:
    Peer keepalive : 30s, Local keepalive: 30s
    Peer holddown  : 90s, Local holddown : 90s
    Connect retry  : 30s
  Timers:
    Connect retry timer : 0s
    keepalive timer     : expires in 10s 882996us
```

```
    Holddown timer      : expires in 1m 12s 538155us
  NLRIs:
    Sent           : ['l2vpn-evpn', 'l2vpn-vpls', 'ipv4-unicast', 'ipv6-unicast',
'ipv4-flowspec', 'ipv6-flowspec', 'ipv4-vpn-unicast', 'ipv6-vpn-unicast', 'ipv4-
vpn-multicast', 'ipv4-labeled-unicast', 'ipv6-labeled-unicast']
    Received       : ['l2vpn-evpn', 'l2vpn-vpls', 'ipv4-unicast', 'ipv6-unicast',
'ipv4-flowspec', 'ipv6-flowspec', 'ipv4-vpn-unicast', 'ipv6-vpn-unicast', 'ipv4-
vpn-multicast', 'ipv4-labeled-unicast', 'ipv6-labeled-unicast']
    Negotiated     : ['l2vpn-evpn', 'l2vpn-vpls', 'ipv4-unicast', 'ipv6-unicast',
'ipv4-flowspec', 'ipv6-flowspec', 'ipv4-vpn-unicast', 'ipv6-vpn-unicast', 'ipv4-
vpn-multicast', 'ipv4-labeled-unicast', 'ipv6-labeled-unicast']
  Capabilities:
    Addpath sent                  : None
    Addpath received              : None
    Addpath negotiated            : None
    Extended nexthop sent         : None
    Extended nexthop received     : None
    Extended nexthop negotiated   : None
    Capabilities:
      Feature                     Sent            Received        Negotiated
      Route refresh               True            True            True
      4 byte AS                   True            True            True
      Graceful restart            False           False           False
      Link local only             False           False           False
  Prefix Limit:
  End of RIB:
    Address family                Sent                                Received
    IPv4 unicast                  Thu Jun 20 09:35:11 GMT +0000 2024  Thu Jun 20
09:35:11 GMT +0000 2024
    IPv4 labeled-unicast          Thu Jun 20 09:35:11 GMT +0000 2024  Thu Jun 20
09:35:11 GMT +0000 2024
    IPv6 unicast                  Thu Jun 20 09:35:11 GMT +0000 2024  Thu Jun 20
09:35:11 GMT +0000 2024
    IPv6 labeled-unicast          Thu Jun 20 09:35:11 GMT +0000 2024  Thu Jun 20
09:35:11 GMT +0000 2024
    IPv4 VPN-unicast              Thu Jun 20 09:35:11 GMT +0000 2024  Thu Jun 20
09:35:11 GMT +0000 2024
    IPv6 VPN-unicast              Thu Jun 20 09:35:11 GMT +0000 2024  Thu Jun 20
09:35:11 GMT +0000 2024
    IPv4 flowspec                 Thu Jun 20 09:35:11 GMT +0000 2024  Thu Jun 20
09:35:11 GMT +0000 2024
    IPv6 flowspec                 Thu Jun 20 09:35:11 GMT +0000 2024  Thu Jun 20
09:35:11 GMT +0000 2024
    IPv4 VPN-multicast            Thu Jun 20 09:35:11 GMT +0000 2024  Thu Jun 20
09:35:11 GMT +0000 2024
    L2VPN VPLS                    Thu Jun 20 09:35:11 GMT +0000 2024  Thu Jun 20
09:35:11 GMT +0000 2024
    L2VPN EVPN                    Thu Jun 20 09:35:11 GMT +0000 2024  Thu Jun 20
09:35:11 GMT +0000 2024
  Message stats:
    Session stats:
      Direction   Open         Update       Keepalive    Notify       Route
refresh
      Input       1            40           235          0            0
      Output      1            52           239          0            0
    Total stats:
      Input       2            80           299          0            0
      Output      2            102          302          1            0
    Route stats:
      Address family                Received     Sent         Prefix limit Idle
timeout
```

```
      IPv4 unicast                  4           4           0           0
      IPv4 labeled-unicast          2           2           0           0
      IPv6 unicast                  4           4           0           0
      IPv6 labeled-unicast          2           2           0           0
      IPv4 VPN-unicast              8           4           0           0
      IPv6 VPN-unicast              6           4           0           0
      IPv4 VPN-multicast            2           6           0           0
      L2VPN VPLS                    7           7           0           0
      L2VPN EVPN                    7           7           0           0
      IPv4 flowspec                 0           8           0           0
      IPv6 flowspec                 0           0           0           0
Peer: , Peer IP: 99.1.1.2, Remote AS: 65002, Local: 99.1.1.1, Local AS:
4200000001, Any AS: False
  Type: ebgp, State: Established, Up/Down Time: 0d:01h:38m:59s, Reason: Cease,
Sub-Code: Admin reset
  Discovered on interface: -
  Last transition: Thu Jun 20 09:35:06 GMT +0000 2024, Flap count: 2
  Peer ID        : 192.168.1.3, Local ID  : 192.168.0.10
  Instance       : default, Peer group: SN
  6PE enabled    : False
  Timer values:
    Peer keepalive : 30s, Local keepalive: 30s
    Peer holddown  : 90s, Local holddown : 90s
    Connect retry  : 30s
  Timers:
    Connect retry timer : 0s
    keepalive timer     : expires in 14s 885374us
    Holddown timer      : expires in 1m 806199us
  NLRIs:
    Sent           : ['ipv4-unicast', 'ipv6-unicast', 'ipv4-flowspec', 'ipv6-
flowspec']
    Received       : ['ipv4-flowspec', 'ipv6-flowspec']
    Negotiated     : ['ipv4-flowspec', 'ipv6-flowspec']
  Capabilities:
    Addpath sent                  : None
    Addpath received              : None
    Addpath negotiated            : None
    Extended nexthop sent         : None
    Extended nexthop received     : ['ipv4-flowspec', 'ipv6-flowspec']
    Extended nexthop negotiated   : None
    Capabilities:
      Feature                      Sent            Received        Negotiated
      Route refresh                True            True            True
      4 byte AS                    True            True            True
      Graceful restart             False           False           False
      Link local only              False           False           False
<...>
```

Example 3: BGP Peer history for a specified peer

```
supervisor@rtbrick.net: op> show bgp peer history peer address 192:168::40
Instance: vrf1
  Peer Address               Source Address             Type             Last
Reset Reason
  192:168::40                192:168:5::20              FSM Error        FSM
Error, Sub-Code: Unexpected message in OpenSent State
```

show bgp rib-in

This command displays the received routes.

Syntax:

show bgp rib-in <option> ...

Option	Description
-	Without any option, the command displays information on the received BGP routing table on all instances in a summary table format.
<afi>	BGP routing table summary for the given address family (AFI), all sub-address families and all instances. Supported AFI values are 'ipv4' and 'ipv6'.
<afi> <safi>	BGP routing table summary for the given address family (AFI) and sub-address family (SAFI), and all instances. Supported SAFI values are 'labeled-unicast', 'unicast', 'vpn-multicast', 'vpn-unicast', ‘evpn-vpws’, ‘evpn’, ‘vpls-vpws’, ‘vpls’, and ‘flowspec’.
<afi> <safi> detail	Detailed list view of the BGP routing table for the given address family (AFI) and sub-address family (SAFI), and all instances.
instance <instance-name> policy-accept	Displays all BGP FlowSpec routes received in the specified address family (ipv4, ipv6, or l2vpn) that were accepted by the BGP import policy.
instance <instance-name> policy-accept detail	Detailed view of the BGP FlowSpec routes received in the specified address family (ipv4, ipv6, or l2vpn) that were accepted by the BGP import policy.
instance <instance-name> policy-deny	Displays all BGP FlowSpec routes received in the specified address family (ipv4, ipv6, or l2vpn) that were denied by the BGP import policy.
instance <instance-name> policy-deny detail	Detailed view of the BGP FlowSpec routes received in the specified address family (ipv4, ipv6, or l2vpn) that were denied by the BGP import policy.

Option	Description
<afi> <safi> <prefix>	BGP routing table entry for the given prefix and all instances.
<afi> <safi> instance <instance-name>	BGP routing table summary for the given AFI, SAFI, and instance.
<afi> <safi> instance <instance-name> detail	Detailed list view of BGP routing table for the given AFI, SAFI, and instance.
<afi> <safi> instance <instance-name> <prefix>	BGP routing table entry for the given prefix and instance.
<afi> <safi> community <community-name>	BGP community details for the given AFI, SAFI, and instance.
<afi> <safi> error	BGP route with error status for the given AFI, SAFI, and instance.
<afi> <safi> peer <name> / peer address <ip>	Peer name or address.

Example 1: Summary view of the BGP rib-in for the ipv4 flowspec address family.

```
supervisor@rtbrick>LEAF01: op> show bgp rib-in ipv4 flowspec
Flags: & - Imported, ! - Error
Instance: default, AFI: ipv4, SAFI: flowspec
Peer IP: 99.1.1.2, Source IP: 99.1.1.1, Total routes: 2
   Flowspec Hash        Match                                          Action
AS Path       Status
   236e3111             src-prefix  : 192.0.2.3/32                     rate-
limit:400.0 kbps   65002         Valid
                        ip-proto    : [ ==tcp or ==udp ]
                        src-port    : [ ==200 or ==100 or ==300 ]
   e05a9523             dest-prefix : 203.0.113.0/24                   discard
65002         Valid
```

Example 2: Summary view of the BGP rib-in for the ipv6 flowspec address family.

```
supervisor@rtbrick>LEAF01: op> show bgp rib-in ipv6 flowspec
Flags: & - Imported, ! - Error
Instance: default, AFI: ipv6, SAFI: flowspec
Peer IP: 99.1.1.2, Source IP: 99.1.1.1, Total routes: 1
   Flowspec Hash                Match
Action                    AS Path       Status
   eff682bf                       src-prefix  : 2001:db8::1/128
rate-limit:500.0 kbps     -              Valid
                               ip-proto    : [ ==udp ]
                               src-port    : [ ==4000 or ==5000 ]
```

Example 3: Summary view of the BGP rib-in for the IPv4 with the error flag.

```
supervisor@rtbrick>rtbrick.net: op> show bgp rib-in ipv4
Flags: & - Imported, ! - Error
Instance: default, AFI: ipv4, SAFI: unicast
  Hostname: Local, Peer IP: 0.0.0.0
  Source IP: 0.0.0.0, Total routes: 4
    Flags  Prefix           Next Hop  MED       Lpref       AS Path
           12.0.0.0/24      -         0         100         -
           12.1.0.0/24      -         0         100         -
           192.168.0.10/32  -         0         100         -
           192.168.0.11/32  -         0         100         -
  Hostname: P1, Peer IP: 12.0.0.2
  Source IP: 12.0.0.1, Total routes: 4
    Flags  Prefix           Next Hop  MED       Lpref       AS Path
           12.0.0.0/24      12.0.0.2  0         -           4200000002
           12.1.0.0/24      12.0.0.2  0         -           4200000002
           192.168.0.20/32  12.0.0.2  0         -           4200000002
           192.168.0.21/32  12.0.0.2  0         -           4200000002
```

show bgp rib-out

This command displays the send routes.

Syntax:

show bgp rib-out <option> ...

Option	Description
-	Without any option, the command displays advertised BGP routes for all instances.
<afi>	BGP routing table summary for the given address family (AFI), all sub-address families and all instances. Supported AFI values are 'ipv4' and 'ipv6'.
<afi> <safi>	BGP routing table summary for the given address family (AFI) and sub-address family (SAFI), and all instances. Supported SAFI values are 'unicast', 'labeled-unicast', 'multicast', 'vpn-unicast', ‘evpn’, ‘vpls’, ‘vpls-vpws’, and ‘flowspec’.
<afi> <safi> detail	Detailed list view of the BGP routing table for the given address family (AFI) and sub-address family (SAFI), and all instances.

Option	Description
<afi> <safi> <prefix>	BGP routing table entry for the given prefix and all instances.
<afi> <safi> instance <instance-name>	BGP routing table summary for the given AFI, SAFI, and instance.
<afi> <safi> instance <instance-name> detail	Detailed list view of BGP routing table for the given AFI, SAFI, and instance.
<afi> <safi> instance <instance-name> <prefix>	BGP routing table entry for the given prefix and instance.
<afi> <safi> peer <name> / peer address <ip>	Peer name or address

Example 1: Summary view of the IPv4 FlowSpec routes advertised to a peer

```
supervisor@rtbrick>LEAF01: op> show bgp rib-out ipv4 flowspec
Instance: default, AFI: ipv4, SAFI: flowspec
  Peer-group: PE2, Sent routes: 2
   Flowspec Hash                Match
Action                       Origin
   236e3111                     src-prefix  : 192.0.2.3/32
rate-limit:400.0 kbps        Incomplete
                                ip-proto    : [ ==tcp or ==udp ]
                                src-port    : [ ==200 or ==100 or ==300 ]
   e05a9523                     dest-prefix : 203.0.113.0/24
discard                      Incomplete
```

Example 2: Summary view of the IPv6 FlowSpec routes advertised to a peer

```
supervisor@rtbrick>LEAF01: op> show bgp rib-out ipv6 flowspec
Instance: default, AFI: ipv6, SAFI: flowspec
  Peer-group: PE2, Sent routes: 1
   Flowspec Hash                Match
Action                       Origin
   eff682bf                     src-prefix  : 2001:db8::1/128
rate-limit:500.0 kbps        Incomplete
                                ip-proto    : [ ==udp ]
                                src-port    : [ ==4000 or ==5000 ]
```

show bgp fib

The 'show bgp fib' commands display the BGP forwarding table. In contrast to the 'show bgp rib' commands, the output of the 'show bgp fib' commands includes only the selected routes. The BGP route selection occurs between the RIB and the

FIB.

Syntax:

show bgp fib <option> ...

Option	Description
-	Without any option, the commands display the BGP forwarding table for all address families and all instances in a summary table format.
afi>	BGP forwarding table summary for the given address family (AFI), all sub-address families and all instances. Supported AFI values are 'ipv4' and 'ipv6'.
<afi> <safi>	BGP forwarding table summary for the given address family (AFI) and sub-address family (SAFI), and all instances. Supported SAFI values are 'unicast', 'labeled-unicast', 'vpn-multicast', 'vpn-unicast', ‘evpn-vpws’, ‘vpls’, ‘vpls-vpws’ and ‘flowspec’.
<afi> <safi> detail	Detailed list view of the BGP forwarding table for the given address family (AFI) and sub-address family (SAFI), and all instances.
<afi> <safi> <prefix>	BGP forwarding table entry for the given prefix and all instances.
<afi> <safi> instance <instance-name>	BGP forwarding table summary for the given AFI, SAFI, and instance.
<afi> <safi> instance <instance-name> detail	Detailed list view of BGP forwarding table for the given AFI, SAFI, and instance.
<afi> <safi> instance <instance-name> <prefix>	BGP forwarding table entry for the given prefix and instance.

Example 1: Summary view of the BGP FIB for IPv4 flowspec address family

```
supervisor@rtbrick>LEAF01: op> show bgp fib ipv4 flowspec
Instance: default, AFI: ipv4, SAFI: flowspec
  Flowspec Hash            Match                                    Action
Priority   Status
  236e3111                 src-prefix  : 192.0.2.3/32               rate-
```

```
limit:400.0 kbps     1502       Installed
                           ip-proto    : [ ==tcp or ==udp ]
                           src-port    : [ ==200 or ==100 or ==300 ]
  e05a9523                 dest-prefix : 203.0.113.0/24                 discard
1501       Installed
```

Example 2: Summary view of the BGP FIB for a specific IPv4 flowspec hash

```
supervisor@rtbrick>LEAF01: op> show bgp fib ipv4 flowspec e05a9523
Instance: default, AFI: ipv4, SAFI: flowspec
  Flowspec hash: e05a9523
    Match:
      dest-prefix:  203.0.113.0/24
    Action:
      discard
    Extended community:
      flowspec:traffic-rate-bytes:0:0.000000
    Priority: 1509
    Status: Installed
    Number of ACL installed: 1
      Rule: bgp-flowspec-e05a95230d1f7153ac561b564947a9457b1083f57fa5cb10
        ACL type: l3v4
        Ordinal: 0               Priority: 1501
        Match:
          Destination IPv4 prefix: 203.0.113.0/24
        Action:
          Drop: True
        Statistics:
                    Total         Accepted      Dropped
          Packets:  45            0             45
          Bytes:    11700         0             11700
```

Example 3: Summary view of the BGP FIB for IPv6 flowspec address family

```
supervisor@rtbrick>LEAF01: op> show bgp fib ipv6 flowspec
Instance: default, AFI: ipv6, SAFI: flowspec
  Flowspec Hash             Match                                        Action
Priority   Status
  eff682bf                 src-prefix  : 2001:db8::1/128                rate-
limit:500.0 kbps     1501       Installed
                           ip-proto    : [ ==udp ]
                           src-port    : [ ==4000 or ==5000 ]
```

Example 4: Summary view of the BGP FIB for a specific IPv4 flowspec address family

```
supervisor@rtbrick>LEAF01: op> show bgp fib ipv4 flowspec 236e3111
Instance: default, AFI: ipv4, SAFI: flowspec
  Flowspec hash: 236e3111
    Match:
      src-prefix:  192.0.2.3/32
      ip-proto:  [ ==tcp or ==udp ]
      src-port:  [ ==200 or ==100 or ==300 ]
```

```
    Action:
      rate-limit:400.0 kbps
    Extended community:
      flowspec:traffic-rate-bytes:0:400000.000000
    Priority: 1502
    Status: Installed
    Number of ACL installed: 6
      Rule: bgp-flowspec-236e31110de8e5920e5caed1e4bc3fe92d570bda99bd49f7
        ACL type: l3v4
        Ordinal: 4               Priority: 1502
        Match:
          Source IPv4 prefix: 192.0.2.3/32
          Source L4 port:: 100
          IP protocol: udp
        ACL type: l3v4
        Ordinal: 3               Priority: 1502
        Match:
          Source IPv4 prefix: 192.0.2.3/32
          Source L4 port:: 200
          IP protocol: udp
        ACL type: l3v4
        Ordinal: 0               Priority: 1502
        Match:
          Source IPv4 prefix: 192.0.2.3/32
          Source L4 port:: 200
          IP protocol: tcp
        ACL type: l3v4
        Ordinal: 2               Priority: 1502
        Match:
          Source IPv4 prefix: 192.0.2.3/32
          Source L4 port:: 300
          IP protocol: tcp
        ACL type: l3v4
        Ordinal: 5               Priority: 1502
<...>
```

Show Command Filter Options for RIB-in, RIB-out, and FIB

Syntax

show bgp fib|rib-in|rib-out <afi> **flowspec filter** <options>

Option	Description
<afi> flowspec filter <options>	Filter BGP Flowspec entries across the RIB based on the option specified.
destination-port	Filters based on destination port number.
destination-prefix	Filters based on the destination IP prefix.

Option	Description
instance-name	Filters entries based on the BGP instance. Useful to verify the Flowspec entries specific to one instance in a multi-instance BGP configurations.
ip-proto	Filters based on the protocol.
port	Filters Flowspec entries based on the protocol port number.
source-port	Filters entries based on the source port. Useful to identify different applications or services originating from specific ports.
source-prefix	Filters entries based on the source IP prefix.

Example 1: Filter BGP RIB-in Flowspec entries based on the port

```
supervisor@rtbrick.net: cfg> show bgp rib-in ipv4 flowspec filter port 3344
Flags: & - Imported, ! - Error
Instance: default, AFI: ipv4, SAFI: flowspec
  Hostname: SN, Peer IP: 23.1.1.3
  Source IP: 23.1.1.1, Total routes: 9999
    Flags  Flowspec Hash                                Match
Action                         AS Path
           647718a2                                     dest-prefix : 10.1.1.1/32
None                           65002
                                                        src-prefix  :
123.123.133.1/32
                                                        ip-proto    : [ ==tcp or
!=ospf or >=udp or <=igmp ]
                                                        port        : [ ==3344 and
>=3345 or >3346 ]
                                                        dst-port    : [ ==3344 and
>=3345 or >3346 ]
                                                        src-port    : [ ==3344 and
>=3345 or >3346 ]
           f547079c                                     dest-prefix : 10.1.1.1/32
None                           65002
                                                        src-prefix  :
123.123.133.1/32
                                                        ip-proto    : [ ==tcp or
!=ospf or >=udp or <=igmp ]
                                                        port        : [ ==3343 and
>=3344 or >3345 ]
                                                        dst-port    : [ ==3343 and
>=3344 or >3345 ]
                                                        src-port    : [ ==3343 and
>=3344 or >3345 ]
           fa25370c                                     dest-prefix : 10.1.1.1/32
None                           65002
                                                        src-prefix  :
123.123.133.1/32
                                                        ip-proto    : [ ==tcp or
```

```
!=ospf or >=udp or <=igmp ]
                                                    port        : [ ==3342 and
>=3343 or >3344 ]
                                                    dst-port    : [ ==3342 and
>=3343 or >3344 ]
                                                    src-port    : [ ==3342 and
>=3343 or >3344 ]
```

Example 2: Filter BGP RIB-in Flowspec entries based on destination prefix

```
supervisor@rtbrick.net: cfg> show bgp rib-in ipv4 flowspec filter destination-
prefix 20.1.1.1/32
Flags: & - Imported, ! - Error
Instance: default, AFI: ipv4, SAFI: flowspec
  Hostname: SN, Peer IP: 23.1.1.3
  Source IP: 23.1.1.1, Total routes: 9999
    Flags  Flowspec Hash                            Match
Action                       AS Path
           36f587c2                                 dest-prefix : 20.1.1.1/32
None                         65002
                                                    src-prefix  :
123.123.133.1/32
                                                    ip-proto    : [ ==tcp or
!=ospf or >=udp or <=igmp ]
                                                    port        : [ ==28 and
>=29 or >30 ]
                                                    dst-port    : [ ==28 and
>=29 or >30 ]
                                                    src-port    : [ ==28 and
>=29 or >30 ]
           dbedeed9                                 dest-prefix : 20.1.1.1/32
None                         65002
                                                    src-prefix  :
123.123.133.1/32
                                                    ip-proto    : [ ==tcp or
!=ospf or >=udp or <=igmp ]
                                                    port        : [ ==9978 and
>=9979 or >9980 ]
                                                    dst-port    : [ ==9978 and
>=9979 or >9980 ]
                                                    src-port    : [ ==9978 and
>=9979 or >9980 ]
```

Example 3: Filter BGP RIB-in Flowspec entries based on source prefix

```
supervisor@rtbrick.net: cfg> show bgp rib-in ipv4 flowspec filter source-prefix
20.123.133.1/32
Flags: & - Imported, ! - Error
Instance: default, AFI: ipv4, SAFI: flowspec
  Hostname: SN, Peer IP: 23.1.1.3
  Source IP: 23.1.1.1, Total routes: 9999
    Flags  Flowspec Hash                            Match
Action                       AS Path
           38bfcfd3                                 dest-prefix : 10.1.1.1/32
None                         65002
                                                    src-prefix  :
```

```
20.123.133.1/32                                                 ip-proto    : [ ==tcp or
!=ospf or >=udp or <=igmp ]                                     port        : [ ==251 and
>=252 or >253 ]                                                 dst-port    : [ ==251 and
>=252 or >253 ]                                                 src-port    : [ ==251 and
>=252 or >253 ]
          5fa337e5                                              dest-prefix : 10.1.1.1/32
None                          65002
                                                                src-prefix  :
20.123.133.1/32                                                 ip-proto    : [ ==tcp or
!=ospf or >=udp or <=igmp ]                                     port        : [ ==9997 and
>=9998 or >9999 ]                                               dst-port    : [ ==9997 and
>=9998 or >9999 ]                                               src-port    : [ ==9997 and
>=9998 or >9999 ]
          91c84623                                              dest-prefix : 10.1.1.1/32
None                          65002
                                                                src-prefix  :
20.123.133.1/32                                                 ip-proto    : [ ==tcp or
!=ospf or >=udp or <=igmp ]                                     port        : [ ==154 and
>=155 or >156 ]                                                 dst-port    : [ ==154 and
>=155 or >156 ]                                                 src-port    : [ ==154 and
>=155 or >156 ]
```

Example 4: Filter BGP RIB-in Flowspec entries based on destination port

```
supervisor@rtbrick.net: cfg> show bgp rib-in ipv4 flowspec filter destination-port
100
Flags: & - Imported, ! - Error
Instance: default, AFI: ipv4, SAFI: flowspec
  Hostname: SN, Peer IP: 23.1.1.3
  Source IP: 23.1.1.1, Total routes: 9999
    Flags  Flowspec Hash                                        Match
Action                        AS Path
          14c614cf                                              dest-prefix : 10.1.1.1/32
None                          65002
                                                                src-prefix  :
123.123.133.1/32                                                ip-proto    : [ ==tcp or
!=ospf or >=udp or <=igmp ]                                     port        : [ ==100 and
>=101 or >102 ]                                                 dst-port    : [ ==100 and
>=101 or >102 ]                                                 src-port    : [ ==100 and
>=101 or >102 ]
          2eaa5fab                                              dest-prefix : 10.1.1.1/32
None                          65002
                                                                src-prefix  :
```

```
123.123.133.1/32
                                                    ip-proto    : [ ==tcp or
!=ospf or >=udp or <=igmp ]
                                                    port        : [ ==99 and
>=100 or >101 ]
                                                    dst-port    : [ ==99 and
>=100 or >101 ]
                                                    src-port    : [ ==99 and
>=100 or >101 ]
          3b8548f9                                  dest-prefix : 10.1.1.1/32
None                          65002
                                                    src-prefix  :
123.123.133.1/32
                                                    ip-proto    : [ ==tcp or
!=ospf or >=udp or <=igmp ]
                                                    port        : [ ==98 and
>=99 or >100 ]
                                                    dst-port    : [ ==98 and
>=99 or >100 ]
                                                    src-port    : [ ==98 and
>=99 or >100 ]
```

Example 5: Filter BGP RIB-in Flowspec entries based on source port

```
supervisor@rtbrick.net: cfg> show bgp rib-in ipv4 flowspec filter source-port  200
Flags: & - Imported, ! - Error
Instance: default, AFI: ipv4, SAFI: flowspec
  Hostname: SN, Peer IP: 23.1.1.3
  Source IP: 23.1.1.1, Total routes: 9999
    Flags  Flowspec Hash                            Match
Action                        AS Path
          908f5353                                  dest-prefix : 10.1.1.1/32
None                          65002
                                                    src-prefix  :
123.123.133.1/32
                                                    ip-proto    : [ ==tcp or
!=ospf or >=udp or <=igmp ]
                                                    port        : [ ==199 and
>=200 or >201 ]
                                                    dst-port    : [ ==199 and
>=200 or >201 ]
                                                    src-port    : [ ==199 and
>=200 or >201 ]
          a6c7b490                                  dest-prefix : 10.1.1.1/32
None                          65002
                                                    src-prefix  :
123.123.133.1/32
                                                    ip-proto    : [ ==tcp or
!=ospf or >=udp or <=igmp ]
                                                    port        : [ ==200 and
>=201 or >202 ]
                                                    dst-port    : [ ==200 and
>=201 or >202 ]
                                                    src-port    : [ ==200 and
>=201 or >202 ]
          c2a0d3e2                                  dest-prefix : 10.1.1.1/32
None                          65002
                                                    src-prefix  :
123.123.133.1/32
```

```
                                                    ip-proto    : [ ==tcp or
!=ospf or >=udp or <=igmp ]
                                                    port        : [ ==198 and
>=199 or >200 ]
                                                    dst-port    : [ ==198 and
>=199 or >200 ]
                                                    src-port    : [ ==198 and
>=199 or >200 ]
```

Example 6: Filter BGP RIB-in Flowspec entries based on IP protocol

```
supervisor@rtbrick.net: cfg> show bgp rib-in ipv4 flowspec filter ip-proto icmp
Flags: & - Imported, ! - Error
Instance: default, AFI: ipv4, SAFI: flowspec
  Hostname: SN, Peer IP: 23.1.1.3
  Source IP: 23.1.1.1, Total routes: 9999
    Flags  Flowspec Hash                            Match
Action                        AS Path
           3dca36d8                                 dest-prefix : 10.1.1.1/32
None                          65002
                                                    src-prefix  :
123.123.133.1/32
                                                    ip-proto    : [ ==tcp or
!=ospf or >=udp or <=igmp or <icmp ]
                                                    port        : [ ==9516 and
>=9517 or >9518 ]
                                                    dst-port    : [ ==9516 and
>=9517 or >9518 ]
                                                    src-port    : [ ==9516 and
>=9517 or >9518 ]
           db68d8a6                                 dest-prefix : 10.1.1.1/32
None                          65002
                                                    src-prefix  :
123.123.133.1/32
                                                    ip-proto    : [ ==tcp or
!=ospf or >=udp or <=igmp or >icmp ]
                                                    port        : [ ==29 and
>=30 or >31 ]
                                                    dst-port    : [ ==29 and
>=30 or >31 ]
                                                    src-port    : [ ==29 and
>=30 or >31 ]
           deb2048d                                 dest-prefix : 10.1.1.1/32
None                          65002
                                                    src-prefix  :
123.123.133.1/32
                                                    ip-proto    : [ ==tcp or
!=ospf or >=udp or <=igmp or <icmp ]
                                                    port        : [ ==9674 and
>=9675 or >9676 ]
                                                    dst-port    : [ ==9674 and
>=9675 or >9676 ]
                                                    src-port    : [ ==9674 and
>=9675 or >9676 ]
```

Validating FlowSpec ACLs

In forwarding, the FlowSpec rules can be validated using the "show acl rule <...>" command as shown in the example below:

Example: Validate BGP FlowSpec ACL rule

```
supervisor@rtbrick>LEAF01: op> show acl rule bgp-flowspec-
b9342ffc0d1f7153ac561b564947a9457b1083f57fa5cb10
Rule: bgp-flowspec-b9342ffc0d1f7153ac561b564947a9457b1083f57fa5cb10
  ACL type: l3v4
  Ordinal: 0             Priority: 1501
    Match:
      Direction: ingress
      Destination IPv4 prefix: 203.0.113.0/24
    Action:
      Stats enabled: True
      Drop: True
    Result:
      ACL Handle: 93
    Statistics:
      Units      Total       Accepted    Dropped
      Packets    45          0           45
      Bytes      11700       0           11700
```

BGP FlowSpec Clear Commands

Clear commands allow to reset operational states.

BGP Peer

This commands resets BGP peerings.

Syntax:

clear bgp peer <option> ...

Option	Description
all	Clears all the BGP peers.
all soft-in <afi> <safi>	Sends route refresh to all neighbors.
all soft-out <afi> <safi>	Re-advertises all the routes previously sent to the peer.
all stats	Clears the statistics of all the BGP peers.

Option	Description
instance <instance> <peer-ip>	Clears the peer for the given instance and peer IP address.
instance <instance> <peer-ip> source <src-ip>	Clears a specific peer for the given peer IP address and source IP address in the specified instance.
instance <instance> all	Clears all peers in the given instance.
instance <instance> <peer-ip> source <src-ip> soft-in <afi> <safi>	Sends route refresh to specific peer for the given instance, peer-ip, source-ip and address-family.
instance <instance> <peer-ip> soft-in <afi> <safi>	Sends route refresh to peer for the given instance, peer-ip and address-family.
instance <instance> all soft-in <afi> <safi>	Sends route refresh to all peers for the given instance and address family.
instance <instance> <peer-ip> source <src-ip> soft-out <afi> <safi>	Re-advertises all the routes previously sent to the specific peer for the given instance, peer-ip, source-ip and address-family.
instance <instance> <peer-ip> soft-out <afi> <safi>	Sends route refresh to peer for a given instance, peer-ip and address-family.
instance <instance> all soft-out <afi> <safi>	Sends route update to all peers for given instance and address family.
instance <instance> <peer-ip> source <src-ip> stats	Clears the statistics of a specific peer for a given instance, peer-ip and source-IP.
instance <instance> <peer-ip> stats	Clears the statistics of the peer for a given instance and peer-IP.
instance <instance> all stats	Clears the statistics of all peers for a given instance.

Example: The example below shows how to clear all the BGP peers.

```
supervisor@rtbrick: op> clear bgp peer all
```

Example: Route Refresh in IPv4/IPv6 for BGP FlowSpec

```
supervisor@rtbrick: op> clear bgp peer all soft-out ipv4 flowspec
supervisor@rtbrick: op> clear bgp peer all soft-in ipv6 flowspec
```

2.5. BGP RPKI-RTR Route Validation

2.5.1. BGP RPKI-RTR Prefix Validation Overview

BGP is the core of the Internet, serving as the backbone protocol that enables exchange of traffic between networks. It plays a crucial role in connecting autonomous systems and ensuring reliable data transmission across the Internet. However, BGP has some inherent security limitations due to its design. It cannot verify whether incoming BGP advertisements come from an authorized autonomous system (AS). This limitation leaves BGP open to various attacks such as route hijacking.

Challenges Due to False Prefix Announcements

Route Hijacking

An attacker can falsely advertise ownership of an IP prefix to redirect or intercept traffic. Also, an autonomous system can incorrectly advertise routes it learned from one provider to other providers. This can be an accidental route leak that directs routes to unintended destinations.

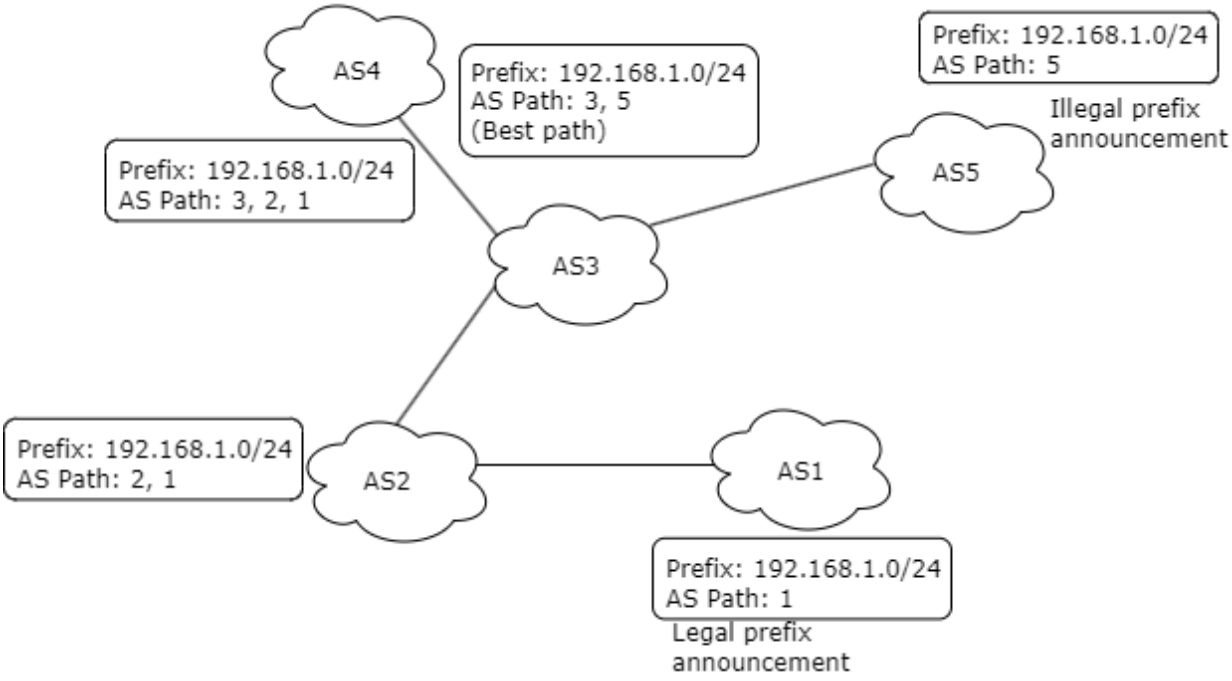


Figure 10. Route Hijacking

The preceding image is an example of a prefix hijacking scenario. ‘AS1’ announces 192.168.1.0/24, while an attacker announces the same prefix from ‘AS5’. ‘AS1’ is the only authorized to originate and announce this prefix on the Internet. ‘AS5’, without authorization, sends a BGP announcement for the same prefix, 192.168.1.0/24. As a result, other ASes on the Internet receive two conflicting announcements for this prefix, one from 'AS1' and another from 'AS5'. AS4 prefers AS5’s announcement due to the shortest AS path. So, AS5’s unauthorized announcement is selected as the best path; traffic intended for 192.168.1.0/24 will be rerouted to 'AS5' instead of 'AS1'.

Route Hijacking occurs in a number of ways:

Prefix Hijacking: An AS can advertise IP prefixes that it does not legitimately own. Attacker can intercept traffic for those prefixes.

AS Path Hijacking: In this scenario, an AS modifies the AS path of a route advertisement to attract traffic that would normally pass through another AS. This can lead to malicious traffic interception or disruption.

Misconfiguration: A simple configuration error can cause large-scale traffic redirection that affects the internet connectivity.

RBFS BGP implements RPKI-RTR based prefix validation mechanism that verifies the authenticity of route announcements before they are accepted and propagated.

Understanding BGP RPKI-RTR Validation Implementation

Resource Public Key Infrastructure (RPKI) is a security framework to protect BGP routes from specific types of attacks like route hijacking and misconfigurations. It provides a way to verify the origin AS of BGP routes, ensuring that only authorized ASs are allowed to advertise specific IP prefixes. It achieves this by cryptographically associating IP address allocations (both IPv4 and IPv6 prefixes) with their rightful owner ISPs or enterprises.

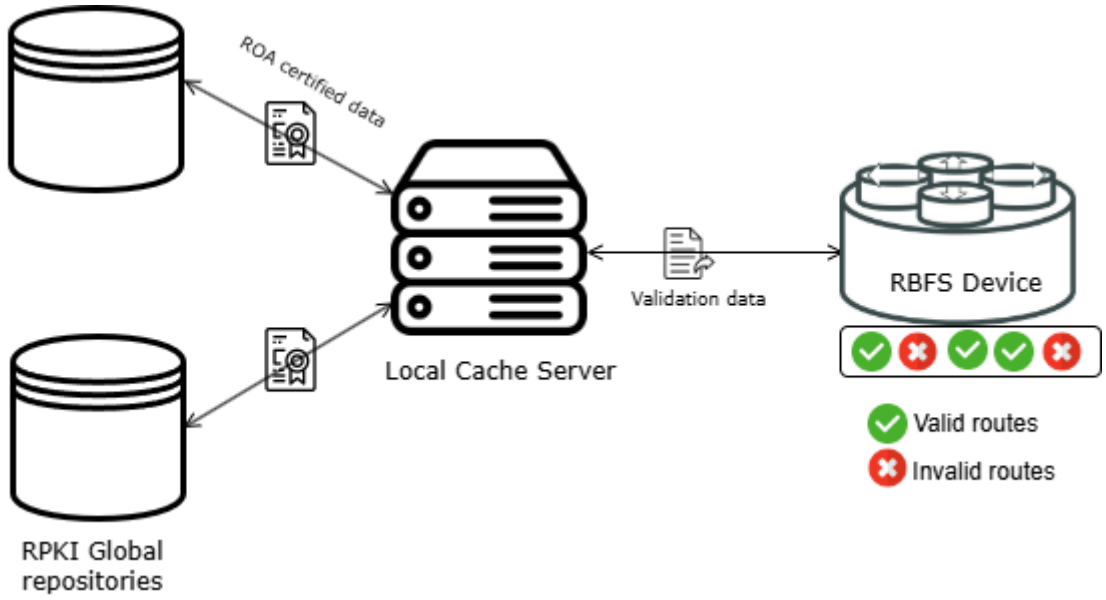


Figure 11. Implementation of BGP RPKI-RTR Validation

Key Components of the Validation Mechanism

Global RPKI Repository

Global RPKI servers are maintained by Regional Internet Registries and other trusted entities. These servers contain cryptographic certificates and Route Origin Authorizations (ROAs) for IP prefixes and ASNs. This is the authoritative source where the reliable information about IP address ownership.

Local Cache Server

ISPs deploy local cache servers, which are configured to regularly synchronize with global RPKI repositories, mirroring the latest ROAs and certified data. The local cache servers serve as intermediaries between the global repository and RBFS devices.

RBFS Device

Once configured, RBFS device establishes secure communication channel with the local cache server for fetching the data using the RTR protocol. Once fetched, the RPKI data is stored locally within the RBFS system. Data are stored in a data table with entries that correspond to valid route origin authorizations. It allows quick lookups for route validation when the device receives a new prefix announcement from a BGP peer.

How RPKI Validation Works

- RPKI Data Repos: Network operators create ROAs which cryptographically bind an IP prefix with an authorized ASN. ROAs are stored in global RPKI repositories which are trusted sources are accessible globally. Local caches servers access the data and stores the verified data.
- RPKI Data: RBFS retrieves of data from cache servers. After establishing a validation session with a cache server, RBFS periodically sends reset queries at refresh intervals. These queries request the complete set of records from the cache. When RBFS receives an end-of-data (EOD) PDU, it performs garbage collection to remove outdated records. RBFS maintains the verified data from the local cache servers and stores the data within the system.
- Route Announcement: When a new prefix is advertised from a peer, RBFS receives the advertisement.
- Validation: RBFS looks up and verifies the ROA to see if the origin AS in the BGP route matches the authorized AS in the ROA using data stored in its RPKI data table. The result of this verification can be 'Valid', 'Invalid', or 'Unknown'.
- Decision: Based on the configured validation filter ('strict', 'loose', ,'mark-only' or 'disable'), the RBFS decides whether to accept or reject the route.

Once the route is validated, RBFS follows decision process as follows:

- Valid Routes: Valid routes are installed into the routing table and used for traffic forwarding.
- Invalid Routes: Invalid routes are discarded if you have configured the filter option as 'loose' or 'strict'. If the filter option is configured with 'mark-only', the routes are accepted and will have to processed in routing policy.
- Unknown: Routes that are not found in the RPKI data will be accepted if you have configured the filter option as loose. Otherwise, this will be discarded.
- Init: Routes learned from BGP sessions that have no validation configured or where the RTR session is down, are marked as init.

This entire process ensures that only verified and authorized routes are propagated within the routing tables.



IP prefixes may change any time. Once configured, an RBFS device continuously validates prefixes in real-time when new BGP route announcements arrive. If the RPKI data changes (for example, a

> new ROA is added or updated), the RBFS device needs to revalidate routes which were accepted or rejected previously. This ensures that only routes verified through RPKI are accepted and malicious route announcements are rejected.

Shared Validation Databases

RBFS allows BGP prefixes in one instance to use the validation database from another VRF instance. It allows for sharing the validation database between routing instances within the system. When a prefix is received in a BGP update, the receiving BGP instance checks its validity by querying the shared database.

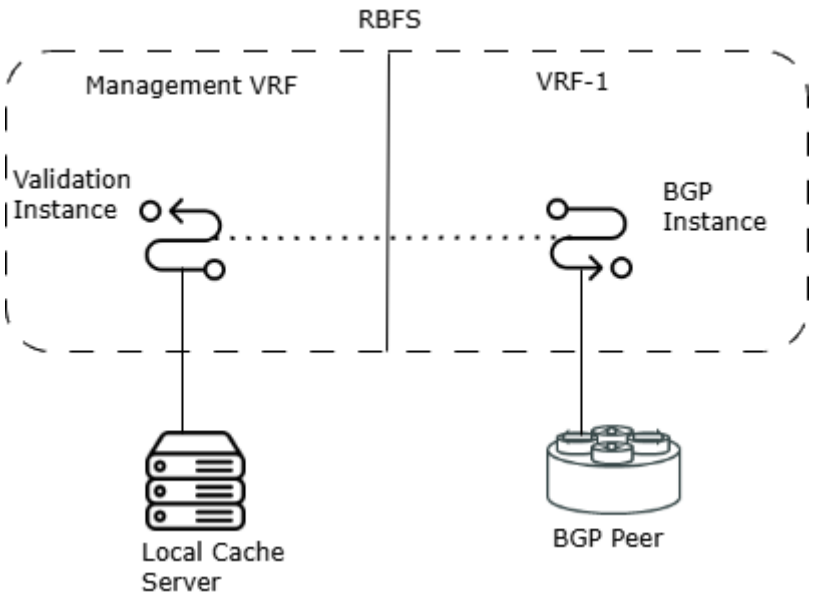


Figure 12. Shared Validation Databases

Timers

With timers, RBFS ensures that the router maintains an up-to-date RPKI validation database. Timers are used to periodically refresh, retry, and expire validation data based on these intervals. RBFS uses timers to maintain synchronization between local cache and RBFS device.

Refresh Interval: Specifies how frequently the router should query the Local Cache to refresh its RPKI validation database. Router polls the cache with Reset Query PDU at Refresh intervals.

Retry Interval: Specifies how long the router should wait before retrying after a failed Reset Query PDU. Router sends Reset Query PDU upon the failed reset query at retry interval.

Expire Interval: Defines how long the router can continue using the current version of the validation database if communication with the Local Cache fails. Router uses the current version of validation database until expire interval.



RBFS clears the validation session and the database after three consecutive unsuccessful reset query attempts at the refresh interval.

Supported Platforms

Not all features are necessarily supported on each hardware platform. Refer to the *Platform Guide* for the features and the sub-features that are or are not supported by each platform.

2.5.2. BGP Prefix Validation Using RPKI-RTR Configuration

Configuration Hierarchy

The diagram illustrates the BGP prefix validation mechanism configuration hierarchy.

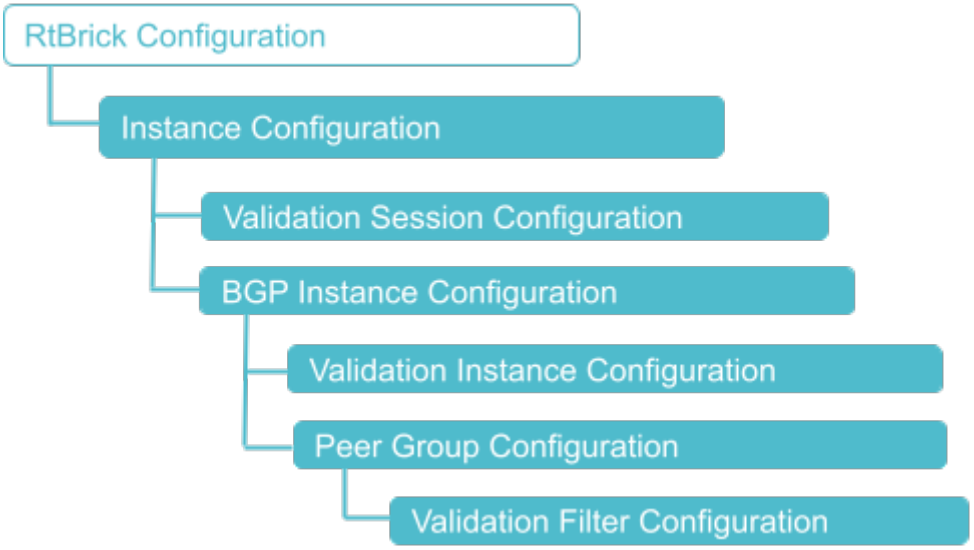


Figure 13. BGP RPKI Configuration Hierarchy

Configuration Syntax and Commands

The following sections describe the BGP RPKI prefix validation configuration syntax and commands.

Configure Validation Session with RPKI Local Cache

The following configuration commands are used to define validation session on an RBFS device. It specifies different session parameters such as cache IP address, update source, port, and preference.

In scenarios where multiple caches are available, the system employs a deterministic method for selecting the preferred cache. The cache preference method provides a way to determine which cache should be used based on configurable priorities.

Cache Preference:

1. When a preference is configured, the cache with the numerically lower preference value is selected.
2. If no preference is configured, or two caches have the same preference value, the selection follows these rules:

    Among IPv4 caches, the cache with the higher IP address is preferred.

    Among IPv6 caches, the cache with the higher IP address is preferred.

    Between IPv4 and IPv6 caches, the IPv4 cache takes precedence over IPv6.

Syntax

set instance <instance-name> **protocol validation session [IPv4|IPv6]** <cache-address> <update-source>

Attribute	Description
cache-address	Cache server IP address.
update-source	Specify the source IP address. This address is used to establish a TCP connection with RPKI cache to fetch RPKI data.
port	Port number used for the RPKI local cache. Range 1 - 65535. Default port is 3323. If you do not configure a port, the default port number is used.

Attribute	Description
preference	Enables RBFS to select the validated route record from the preferred cache. Range 1 - 255. A numerically lower preference value indicates the higher preference.

Example: Validation session with the RPKI local cache

The following configuration sets up RPKI validation for both IPv4 and IPv6 routes in BGP. IPv4 session connects the router to an RPKI cache server with the RTR protocol, using the specified cache server IP address 192.168.5.50. The update-source, that is source IP address, is specified to 192.168.5.20 for the IPv4 session. The port number that is used for RTR communication is specified to '3345' for the session.

For the IPv6 session, the cache server IP address is specified to 192:168:5::50 and the source IP is specified 192:168:5::20. The port number is specified 3346 that is used for RTR communication.

The preference value for the IPv4 session is set to 100, while the preference value for the IPv6 session is set to 10. The preference value determines which session is prioritized when both sessions are available. A lower numerical preference value indicates a higher preference. In this scenario, the IPv6 session has a higher preference because it has a lower value, meaning that the IPv6 session will take priority over the IPv4 session.

```
set instance vrf-blue protocol validation session ipv4 192.168.5.50 192.168.5.20
set instance vrf-blue protocol validation session ipv6 192:168:5::50 192:168:5::20
port 3345
set instance vrf-blue protocol validation session ipv4 192.168.5.50 192.168.5.20
preference 100
set instance vrf-blue protocol validation session ipv6 192:168:5::50 192:168:5::20
set instance vrf-blue protocol validation session ipv6 192:168:5::50 192:168:5::20
port 3346
set instance vrf-blue protocol validation session ipv6 192:168:5::50 192:168:5::20
preference 10
```

The following example shows the validation session with RPKI local cache.

```
supervisor@rtbrick.net: cfg> show config instance vrf-blue protocol validation
{
  "rtbrick-config:validation": {
    "session": {
      "ipv4": [
```

```
        {
          "cache-address": "192.168.5.50",
          "update-source": "192.168.5.20",
          "port": 3345,
          "preference": 100
        }
      ],
      "ipv6": [
        {
          "cache-address": "192:168:5::50",
          "update-source": "192:168:5::20",
          "port": 3346,
          "preference": 10
        }
      ]
    }
  }
}
```

To access the RESTCONF API that corresponds to this CLI, click here.

Configure BGP Validation Instance

Syntax

set instance <instance-name> **protocol bgp validation-instance** <validation-instance>

Attribute	Description
<validation-instance>	Validation instance name.

Example: Validation Instance configuration

The following configuration sets up 'vrf-blue' as a validation instance.

```
set instance default protocol bgp validation-instance vrf-blue
```

The following example shows validation instance as vrf-blue.

```
supervisor@rtbrick.net: cfg> show config instance default protocol bgp validation-
instance
{
  "rtbrick-config:validation-instance": "vrf-blue"
}
```

Configure BGP Validation Filter

Validation filter can be configured under a specific BGP peer group.

Syntax

set instance <instance-name> **protocol bgp peer-group** <pg-name> **validation-filter** [strict|loose|mark-only|disable]

Attribute	Description
strict	BGP accepts only the valid routes.
loose	BGP accepts both valid routes and unknown routes. But it rejects routes with invalid RPKI data.
mark-only	BGP will accept valid, invalid and unknown routes. All RPKI validation state processing must be done in routing policy.
disable	No route validation is performed. Routes are installed based on the BGP route selection process.

Example: Validation filter configuration

The following configuration defines the validation filter. The validation filter is defined as 'loose' that means BGP can accept both valid routes and unknown routes, but it rejects routes with invalid RPKI data.

```
set instance default protocol bgp peer-group P2 validation-filter loose
```

The following example shows the validation filter as "loose.""

```
supervisor@rtbrick.net: cfg> show config instance default protocol bgp peer-group
P2 validation-filter
{
  "rtbrick-config:validation-filter": "loose"
}
```

The following example shows the configuration of BGP validation filter "mark-only."

```
set instance default protocol bgp peer-group pg1 validation-filter mark-only
```

```
supervisor@rtbrick>LEAF01: cfg> show config instance default protocol bgp peer-group pg1 validation-filter
{
  "rtbrick-config:validation-filter": {
    "mark-only": "true"
  }
}
```

Ignoring RPKI Validation State When Selecting BGP Best Route

RBFS can be configured to ignore the RPKI Validation State while selecting the BGP best route. It is recommended to exercise caution when doing this, as this can cause unexpected results such as black holes and routing loops.



Both "validation-filter mark-only" and "ignore-validation-state true" must be configured to enable proper processing in policy.

Syntax:

set instance <instance-name> **protocol bgp bestroute-selection ignore-validation-state** < **false** | **true** >

The following example shows the configuration for ignoring the RPKI validation state.

```
set instance default protocol bgp bestroute-selection ignore-validation-state true
```

```
supervisor@rtbrick>LEAF01: cfg> show config instance default protocol bgp bestroute-selection
{
  "rtbrick-config:bestroute-selection": {
    "ignore-validation-state": "true"

  }
}
```

2.5.3. BGP Route Validation with RPKI-RTR Operational Commands

BGP RPKI-RTR Show Commands

The BGP RPKI-RTR show commands provide detailed information about the BGP

RPKI-RTR route validation operations.

Validation Session

The show validation session command and options provide information about the TCP session information between RBFS and the local caches.

Syntax:

show validation session <option>

Option	Description
-	Without any option, it displays information about all the validation session.
cache	Displays validation session information filtered by a specific cache address.
detail	Provides detailed information about each validation session.
instance	Displays validation session information for a specific instance.
source	Displays validation session information filtered by a specific source IP address.

Example: Validation session

```
supervisor@rtbrick.net: cfg> show validation session
Instance: vrf-blue
  Cache                         Source                    State         Up/Down
Time     IPv4 Rcvd   IPv6 Rcvd
  192.168.5.50                  192.168.5.20              Established
0d:00h:34m:12s     4048744      986282
  192:168:5::50                 192:168:5::20             Established
0d:00h:34m:12s     4048734      986261
```

API To access the Operational State API that corresponds to this CLI, click include::common:partial$operational_api_links.adoc[tag=show_validation].

Validation Cache-in

The show validation cache-in command provides cache information.

Syntax:

```
show validation cache-in <option>
```

The show command and options provide detailed information about the received validation route records from the local caches.

Option	Description
-	Without any option, it displays information about the prefix validation data for all caches and source IPs.
afi	Filters the cache-in validation data based on the address family, such as IPv4 or IPv6.
cache	Displays validation information related to a specific cache address.
instance	Filters the validation data for a specific instance.
prefix	Displays validation information for a specific prefix.

API To access the Operational State API that corresponds to this CLI, click include::common:partial$operational_api_links.adoc[tag=show_validation].

Example: Information for the specific cache.

```
supervisor@rtbrick.net: cfg> show validation cache-in instance default cache
10.1.1.2
Instance: default  AFI: ipv4
  Cache IP: 10.1.1.2  Source IP: 10.1.1.1  Total Prefixes: 443092
    Prefix                                    As Num    Max Len
    1.0.0.0/24                                 13335         24
    3.0.0.0/10                                 16509         24
    3.0.0.0/15                                 16509         24
    5.0.0.0/19                                 29256         19
    20.0.0.0/11                                 8075         11
    23.0.0.0/12                                20940         12
    23.0.0.0/24                                20940         24
    24.0.0.0/12                                 7922         12
    24.0.0.0/16                                33659         16
    27.0.0.0/22                                16509         24
    31.0.0.0/16                                 8374         16
    <...>
```

Validation Database

The validation database contains preferred validation route records based the cache preference. The show validation database provides detailed information about the validation database, which is used for prefix validation.

Syntax:

show validation database <option>

Option	Description
-	Without any option, it displays the information about all validation databases.
afi	Filters the validation database based on the address family, such as IPv4 or IPv6.
as-num	Displays validation information for a specific Autonomous System (AS).
cache	Displays database entries associated with a specific cache address.
instance	Displays database information for a specific instance.
prefix	Filters the database to show validation details for a specific prefix.
summary	Provides a summary of the validation database.

API To access the Operational State API that corresponds to this CLI, click include::common:partial$operational_api_links.adoc[tag=show_validation].

Example 1: Validation database information

```
supervisor@rtbrick.net: cfg> show validation database
Instance: vrf-blue, AFI: ipv4
  Prefix                                    As Num    Max Len    Cache
  1.0.0.0/24                                 13335         24    192:168:5::50
  3.0.0.0/10                                 16509         24    192:168:5::50
  3.0.0.0/15                                 16509         24    192:168:5::50
  5.0.0.0/19                                 29256         19    192:168:5::50
  20.0.0.0/11                                 8075         11    192:168:5::50
  23.0.0.0/12                                20940         12    192:168:5::50
  23.0.0.0/24                                20940         24    192:168:5::50
```

Example 2: Validation database information for a specific AS number.

```
supervisor@rtbrick.net: cfg> show validation database as-num 5089
Instance: vrf-blue, AFI: ipv4
  Prefix                                    As Num    Max Len    Cache
  80.0.0.0/13                                 5089         17    192:168:5::50
  82.0.0.0/12                                 5089         12    192:168:5::50
  82.0.0.0/13                                 5089         13    192:168:5::50
  82.0.0.0/14                                 5089         14    192:168:5::50
  86.0.0.0/11                                 5089         11    192:168:5::50
  86.0.0.0/13                                 5089         13    192:168:5::50
  86.0.0.0/14                                 5089         14    192:168:5::50
  86.0.0.0/15                                 5089         15    192:168:5::50
  86.0.0.0/16                                 5089         16    192:168:5::50
  86.1.0.0/16                                 5089         16    192:168:5::50
```

Example 3: Validation database summary

```
supervisor@rtbrick.net: cfg> show validation database summary
Instance: vrf-blue
IPv4 Prefix: 452282
IPv6 Prefix: 113149
```

Clear Commands

Clear Validation Session

The clear validation session command and options are used to remove or reset data related to validation session.

Syntax:

clear validation session <option>

Option	Description
all	Resets all existing validation sessions (without clearing the database).
all soft	Refreshes the only the validation database by sending a reset query to the cache.
instance	Resets validation sessions per instance.

Example: Clearing validation session options

```
clear validation session all
clear validation session all soft
clear validation session instance vrf-blue
clear validation session instance vrf-blue 192.168.5.50 source 192.168.5.20 soft
```

API To access the Operational State API that corresponds to this CLI, click include::common:partial$operational_api_links.adoc[tag=clear_validation_session].

Clear Validation Database

The clear validation database command is used to remove entries in the validation database.

Syntax:

clear validation database <option>

Option	Description
all	Clears all entries in the validation database.
instance	Clears validation database for a specific instance.

Example: Clearing validation database options

```
clear validation database all
clear validation database instance vrf-blue
clear validation database instance vrf-blue 192.168.5.50 source 192.168.5.20
```

API To access the Operational State API that corresponds to this CLI, click include::common:partial$operational_api_links.adoc[tag=clear_validation_database].

2.6. IS-IS

2.6.1. IS-IS Overview

IS-IS, or Intermediate System to Intermediate System, is an open standard routing protocol. ISO published the standard as a way to route datagrams as part of their OSI stack. IETF later republished the standard, and added IP route support.

It is a link-state routing protocol, similar to OSPF. It forms neighbor adjacencies, has areas, exchanges link-state packets, builds a link-state database and runs the Dijkstra SPF algorithm to find the best path to each destination, which is installed in the routing table.

IS-IS Segment Routing

IS-IS in RBFS supports segment routing based on RFC 8667. IS-IS Segment Routing enhances the IS-IS protocol by introducing new TLVs to carry segment routing information within IS-IS protocol packets. It introduces Segment IDs (SIDs) to represent different types of segments, such as prefix SIDs (node SIDs and anycast SIDs) and adjacency SIDs.



RFC and draft compliance are partial except as specified.

IS-IS Support Over Unnumbered Interfaces

An unnumbered interface is a point-to-point interface that is not explicitly configured with a dedicated IP address; instead, it borrows an IP address from a loopback interface. IS-IS can be set up over an unnumbered interface, enabling each router to use a loopback IP address to establish an IS-IS adjacency.

For details on configuring an unnumbered interface, refer to the Logical Interface Configuration section of the *Interfaces User Guide*.

IS-IS Route Leaking from Level 2 to Level 1

RBFS supports Level 2 to Level 1 route leaking in IS-IS. This feature allows Level 1 routers to learn specific Level 2 routes that are not automatically leaked to Level 1. By default, Level 1 routers reach other IS-IS levels (outside their area) by sending packets to the nearest Level 1/2 router via a default route.

In an IS-IS environment with LDP, Level 1 routers need to learn the loopback addresses of routers outside their area to establish LSPs (Label Switched Paths). Therefore, specific IP addresses must be leaked from Level 2 to Level 1 to provide required routing information. This feature allows a policy-based configuration on the Level 1/2 routers that connect the two levels. Route leaking selectively leaks particular Level 2 routes into Level 1 areas using predefined route policies.

Supported Platforms

Not all features are necessarily supported on each hardware platform. Refer to the *Platform Guide* for the features and the sub-features that are or are not supported by each platform.

2.6.2. IS-IS Configuration

Configuration Hierarchy

The diagram below illustrates the IS-IS configuration hierarchy.

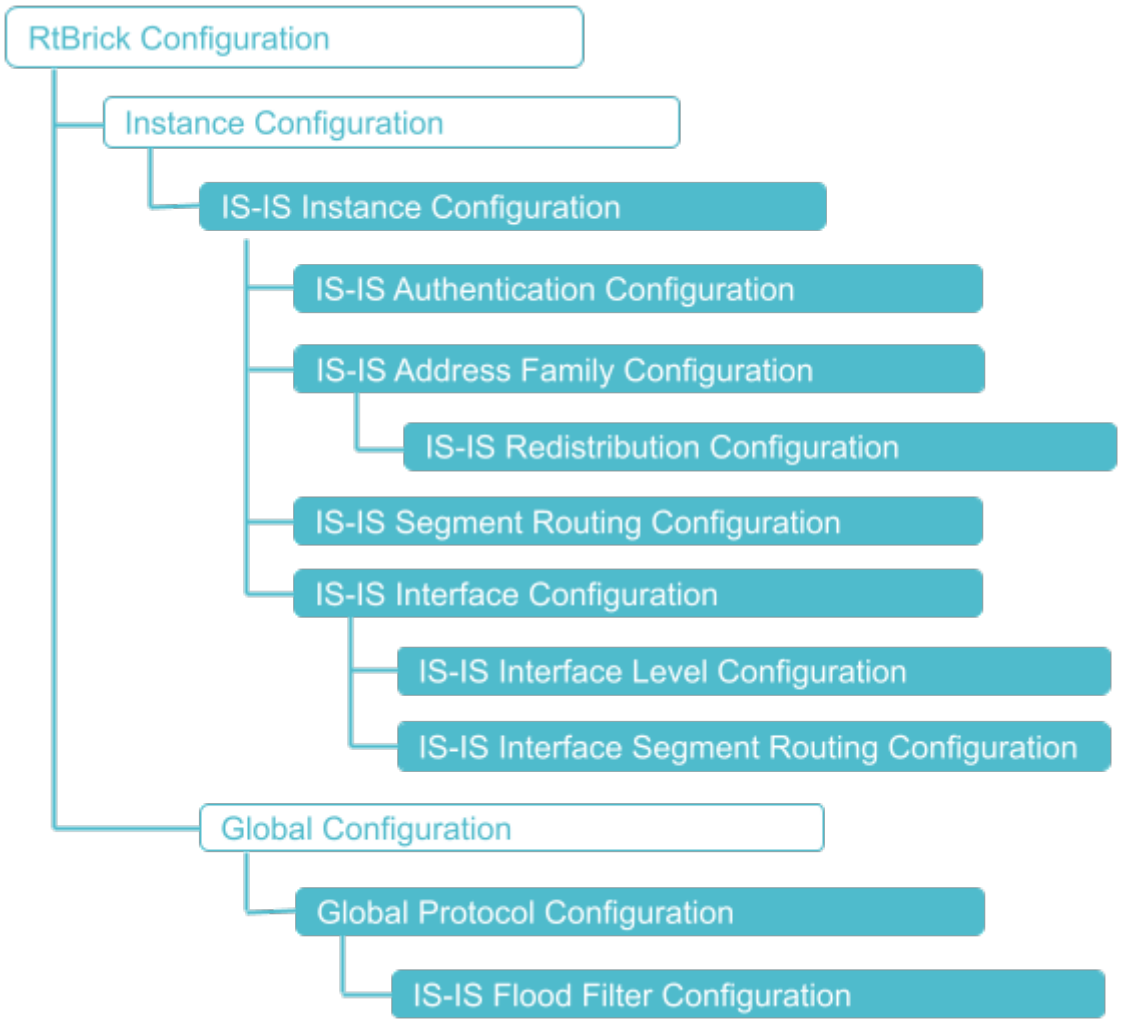


Figure 14. IS-IS Configuration Hierarchy

Configuration Syntax and Commands

The following sections describe the IS-IS configuration syntax and commands.

Instance Configuration

The instance configuration hierarchy includes parameters that are required for or used by IS-IS.

Syntax:

set instance <instance-name> **protocol isis** <attribute> <value>

Attribute	Description
<name>	Name of the IS-IS instance
area <area>	IS-IS area-address. The area can be represented in 1, 3, 5, 13 bytes format.
authentication <...>	Specifies the authentication scheme for IS-IS. Refer to section IS-IS Authentication Configuration for the IS-IS authentication configuration details.
holding-time <holding-time>	Specifies how long a neighbor should consider this routing device to be operative without receiving another hello packet. Default value: 30 seconds Range: 3 to 180 seconds
hostname <hostname>	Specifies the hostname mapped to the system identifier.
ignore-attached-bit [true/false]	This configuration allows you to enable the routing device to ignore the attached bit on incoming Level 1 link-state PDUs. If the attached bit is ignored, no default route, which points to the routing device which has set the attached bit, is installed. Default: 'false'.
interface <...>	Name of the interface. Refer to section Configuring IS-IS Interface for the interface configuration details.

Attribute	Description
ipv6-disable [true/false]	Specifies whether the ipv6-disable configuration is enabled or not. When you set this value to "true", it indicates that IPv6 configuration is disabled. Default: False.
[level-1/level-2] address-family <...>	Protocol ISIS level-1/level-2 address-family configuration. Refer to section IS-IS Address-Family Configuration for the address family configuration details.
level1-to-level2 route-leak [enable/disable]	Specifies whether the level1-to-level2 route-leak is enabled or not. When set to disable, IS-IS will not leak routing information from a Level 1 area to a Level 2 area. By default, this option is enabled.
lsp-lifetime <lsp-lifetime>	IS-IS link-state PDUs maximum lifetime. Default value: 65535 seconds. Range: 317 - 65535.
multipath <multipath>	Load sharing among multiple IS-IS paths.  The default ECMP Maximum Next-hop Count is limited to 8; however, this limit varies depending on the platform that RBFS supports. For details on the limits set for the ECMP Maximum Next-hop Count on the platforms, refer to the undefined/techdocs/current/platform/resource_limit.html[Resource Limits/Feature Support] section of the *Platform Guide*.
no-mpls-transit-path [true/false]	When set to true, IS-IS will not install segment routing transit path. Default: false
overload [true/false]	When set to true, IS-IS overload bit is set. Default: false
router-id <router-id>	ISIS router identifier (ipv4 format: A.B.C.D)
system-id <system-id>	Specifies the system ID of the device.

Example: IS-IS Instance Configuration

The following configuration defines the instance 'default'.

```
supervisor@rtbrick: cfg>show config instance default protocol isis
{
  "rtbrick-config:isis": {
    "system-id": "1921.6800.1001",
    "area": [
      "49.0001/24"
      ],
    "hostname": "isr1",
 <...>
```

Example: Disabling IS-IS Route Leaking from a Level 1 Area to a Level 2 Area

The following configuration defines IS-IS route leaking behavior between Level 1 and Level 2 routing domains.

```
set instance default protocol isis level1-to-level2 route-leak disable
```

```
supervisor@rtbrick: cfg> show config instance default protocol isis level1-to-
level2
{
  "rtbrick-config:level1-to-level2": {
    "route-leak": "disable"
  }
}
```

API To access the RESTCONF API that corresponds to this CLI, click here.

IS-IS Authentication Configuration

Syntax:

set instance <instance-name> **protocol isis authentication** [**level-1** | **level-2**] <attribute> <value>

Attribute	Description
check [disable | enable]	Specifies an authentication check to reject PDUs that do not match the type or key requirements. You can enable or disable the authentication check.
key-id1 <key-id1> / key-id2 <key-id2>	The key ID allows you to specify the key identifiers for level-1/level-2 authentication.

Attribute	Description
key1-encrypted-text <key1-encrypted-text> / key2-encrypted-text <key2-encrypted-text>	Authentication key1 and key 2 encrypted text
key1-plain-text <key1-plain-text> / key2-plain-text <key2-plain-text>	The level-1/level-2 authentication keys specify the authentication keys (passwords) that are used by the neighboring routing devices to verify the authenticity of packets sent from this interface. For the key to work, you also must include the authentication-type statement.
type	Enables you to specify the authentication type for IS-IS. If you enable authentication, you must specify a password by including the authentication-key statement. The following authentication types are supported: • clear_text: Simple password authentication. • md5: Message-Digest Algorithm 5. • sha1: Secure Hash Algorithm 1. • sha224: Secure Hash Algorithm 224. • sha256: Secure Hash Algorithm 256. • sha384: Secure Hash Algorithm 384. • sha512: Secure Hash Algorithm 512.

Example configuration for IS-IS authentication.

The following configuration sets up authentication for IS-IS protocol at both level-1 and level-2. For both level-1 and level-2, the authentication type is set to 'md5'. It indicates that MD5 will be used to secure IS-IS routing updates. The authentication keys for level-1: key1-encrypted-text is set to "$24a6f10525a11077bec3b451be8855877" and for level-2 key1-encrypted-text is set to "$2d787015bf84f3b58d5fd393a96c9639c". These key1-encrypted-text values are the encrypted (hashed) passwords used for authentication at each level.

```
set instance default protocol isis authentication level-1 type md5
set instance default protocol isis authentication level-1 key1-encrypted-text
"$24a6f10525a11077bec3b451be8855877"
set instance default protocol isis authentication level-2 type md5
set instance default protocol isis authentication level-2 key1-encrypted-text
"$2d787015bf84f3b58d5fd393a96c9639c"
```

```
supervisor@rtbrick: cfg> show config instance default protocol isis authentication
{
  "rtbrick-config:authentication": {
    "level-1": {
      "type": "md5",
      "key1-encrypted-text": "$24a6f10525a11077bec3b451be8855877"
    },
    "level-2": {
      "type": "md5",
      "key1-encrypted-text": "$2d787015bf84f3b58d5fd393a96c9639c"
    }
  }
}
```

API To access the RESTCONF API that corresponds to this CLI, click here.

IS-IS Address-Family Configuration

The address-family command allows you to enable the address families that IS-IS will route and configure settings that are specific to that address family.

Syntax:

set instance <instance-name> **protocol isis** [**level-1** | **level-2**] **address-family** <attribute> <value>

Attribute	Description
<afi>	Address family identifier (AFI). Supported values: ipv4, ipv6
<safi>	Subsequent address family identifier (SAFI). Supported values: unicast or labeled-unicast

API To access the RESTCONF API that corresponds to this CLI (level-1), click here.

API To access the RESTCONF API that corresponds to this CLI (level-2), click here.

Configuring Route Redistribution

Syntax:

set instance <instance-name> **protocol isis** [**level-1** | **level-2**] **address-family** <afi> <safi> **redistribute** <attribute> <value>

Attribute	Description
<afi>	Address family identifier (AFI). Supported values: ipv4, ipv6
<safi>	Subsequent address family identifier (SAFI). Supported values: unicast or labeled-unicast
redistribute <protocol>	Specifies the source from which the routes are to be redistributed from. The available options include arp-nd, bgp, bgp-local, bgp-local-origin, direct, igmp, ospf, l2tpv2, ldp, local, pim, ppp, rib, and static.
redistribute <protocol> <policy>	Specifies the name of the policy map. The redistribute attach point allows routes from other sources to be advertised by IS-IS. Policy can be applied only to the routes that are redistributed from other sources to IS-IS. The support for inter-level leaking through policy is unavailable.

Example: IS-IS address-family and route redistribution configuration

The following configuration defines how the IS-IS protocol at Level 1 will redistribute static routes for both IPv4 and IPv6 unicast address families. It sets up the IS-IS protocol within the "default" instance, specifically targeting Level 1 of the IS-IS hierarchy. For the IPv4 unicast address family, it specifies that routes learned from a static source should be redistributed. The policy applied during this redistribution is referred to as 'filter-link-address'.

Similarly, the configuration addresses the IPv6 unicast address family, redistributing routes from a static source. The policy applied is named 'filter-link6-address', which will be enforced during the redistribution of IPv6 routes.

```
set instance default protocol isis level-1 address-family ipv4
set instance default protocol isis level-1 address-family ipv4 safi unicast
```

```
set instance default protocol isis level-1 address-family ipv4 redistribute static
set instance default protocol isis level-1 address-family ipv4 redistribute static
policy filter-link-address
set instance default protocol isis level-1 address-family ipv6
set instance default protocol isis level-1 address-family ipv6 safi unicast
set instance default protocol isis level-1 address-family ipv6 redistribute static
set instance default protocol isis level-1 address-family ipv6 redistribute static
policy filter-link6-address
```

```
supervisor@rtbrick: cfg> show config instance default protocol isis level-1
{
  "rtbrick-config:level-1": {
    "address-family": [
      {
        "afi": "ipv4",
        "safi": "unicast",
        "redistribute": [
          {
            "source": "static",
            "policy": "filter-link-address"
          }
        ]
      },
      {
        "afi": "ipv6",
        "safi": "unicast",
        "redistribute": [
          {
            "source": "static",
            "policy": "filter-link6-address"
          }
        ]
      }
    ]
  }
}
```



To access the RESTCONF API that corresponds to this CLI (level-1), click here.



To access the RESTCONF API that corresponds to this CLI (level-2), click here.

Segment Routing Configuration

IS-IS segment routing extensions allow to advertise labels with prefixes.

RBFS currently supports the following IS-IS segment routing features:

- MPLS data plane
- IPv4 prefixes (TLV 135) and IPv6 prefixes (TLV 236)
- Prefix SID with node flag (Node SID) on loopback interface

- Anycast SID
- A single global SRGB block
- Adjacency SIDs

Syntax:

set instance <instance-name> **protocol isis segment-routing** <attribute> <value>

Attribute	Description
`srgb base <srgb base>'	Specifies the segment routing global block (SRGB) in source packet routing. SRGB is used for prefix SIDs. Supported MPLS label values range: 256 - 499968 In RBFS, BGP uses the label range 20000 - 100000. It is recommended to assign label values outside of these reserved ranges to avoid conflicts.
srgb range <srgb range>	IS-IS system range of labels from the base label. Range: 0 - 499968.  For details on the supported label ranges, see the undefined/techdocs/current/platform/resource_limit.html#static-system-dynamic-label-ranges[Static, System, and Dynamic Label Ranges] section in the Platform Guide.
srlb base <srlb base>	Specifies the segment routing local block (SRLB) in source packet routing. SRLB is used for adjacency SIDs. Supported MPLS label value range: 256 - 499968. In RBFS, BGP uses the label range 20000 - 100000. It is recommended to assign label values outside of these reserved ranges to avoid conflicts.

Attribute	Description
srlb range <srlb range>	IS-IS system range of labels from the base label. Range: 0 - 499968. For details on the supported label ranges, see the undefined/techdocs/current/platform/resource_limit.html#static-system-dynamic-label-ranges[Static, System, and Dynamic Label Ranges] section in the Platform Guide.

Example: IS-IS Segment Routing Configuration

This configuration establishes segment routing for the IS-IS instance. It defines two Segment Routing Global Blocks (SRGBs) and two Segment Routing Label Blocks (SRLBs). The SRLB has a base value of 2000 and a range of 1000, which means it will use labels from 2000 to 2999. Similarly, the SRGB has a base value of 1000 and a range of 1000, allowing it to use labels from 1000 to 1999. These values are essential for assigning Segment Identifiers (SIDs) within a Segment Routing domain.

```
set instance default protocol isis segment-routing srlb base 2000
set instance default protocol isis segment-routing srlb range 1000
set instance default protocol isis segment-routing srgb base 1000
set instance default protocol isis segment-routing srgb range 1000
```

```
supervisor@rtbrick>spine1: cfg> show config instance default protocol isis
segment-routing
{
  "rtbrick-config:segment-routing": {
    "srlb": {
      "base": 2000,
      "range": 1000
    },
    "srgb": {
      "base": 1000,
      "range": 1000
    }
  }
}
```

To access the RESTCONF API that corresponds to this CLI, click here.

Configuring IS-IS Interface

By default, there are no interfaces associated with IS-IS. You must configure at least one IS-IS interface for IS-IS adjacency formation.

Syntax:

set instance <instance> **protocol isis interface** <name> <attribute> <value>

Attribute	Description
<name>	Specifies the name of the IS-IS interface. IS-IS can be configured on both numbered and unnumbered interfaces.
flood-filter <flood-filter>	Specifies the IS-IS flood filter name
hello-interval	Specifies IS-IS system interface hello interval. Range: 1 - 600, Default :10s.  To configure hello-interval, the user can either configure holding-time/hello-interval under interface or hello-interval under level [broadcast interface only]. The order of priority, from highest to lowest, is as follows: * For Broadcast interface type: hello-interval under interface level 1/2 > hello-interval under interface > holding-time under instance * For Point-to-Point interface type: hello-interval under interface > holding-time under instance
level-1 / level-2	Specify IS-IS interface level configuration. Refer to section IS-IS Interface Level Configuration for the IS-IS interface level configuration details.
lsp-interval <lsp-interval>	IS-IS system interface LSP interval. Default value: 100. Range: 1 - 1000.

Attribute	Description
passive [true / false]	Enable interface in passive mode. Default: false
system-id <system-id>	Interface level system id
type [broadcast / point-to-point]	Specifies the type of the IS-IS system interface. Default: point-to-point. broadcast—Specifies a broadcast (or LAN) interface. point-to-point—Specifies a point-to-point interface.
ldp-synchronization [enable / disable]	Enable LDP IGP synchronization. Default: disable
segment-routing <afi> no-penultimate-pop <true | false>	Enables (true) or disables (false) no-penultimate-hop-pop. Default: false The “no-penultimate-pop” configuration ensures that the second-to-last router (penultimate hop) in a Label Switched Path (LSP) does not remove (or does not "pop") the MPLS label from a packet before forwarding it to the egress router.
segment-routing <afi> explicit-null <true | false>	Enables (true) or disables (false) explicit-null. Default: false. The "explicit-null" configuration assigns an explicit null label (0) for IPv4 and an explicit null label (2) for IPv6 to the penultimate router. The “no-penultimate-pop” feature must be configured to enable “explicit-null”.

Example: IS-IS Interface Configuration

The following configuration defines the IS-IS protocol settings for three interfaces: ifl-0/0/2/0, ifl-0/0/2/1, and lo-0/0/0/0. It specifies parameters such as interface types (point-to-point and broadcast), authentication settings, LSP (Link State Protocol) intervals, LDP (Label Distribution Protocol) synchronization, metrics, priorities, and hello intervals for both Level-1 and Level-2 IS-IS on each of these interfaces. Also, it configures Segment Routing with IPv4 and IPv6 SID (Segment Identifier) indices for the loopback interface.

For the interface ifl-0/0/2/0, the type is set to point-to-point, indicating that this interface is configured for a direct, one-to-one connection. The passive setting is set to false, meaning IS-IS will send and receive hello messages on this interface. Both SNP (Synchronized Network Protocol) and hello authentication for Level-1 are

disabled.

For the interface ifl-0/0/2/1, a flood filter named spine1_lsr1_flood_filter is applied to control the flooding of IS-IS LSPs. This interface type is defined as broadcast, indicating that it is a multi-access interface. The LSP interface interval is set to 200, which determines the time interval at which LSPs are generated. LDP synchronization is enabled that allows synchronization between IS-IS and LDP. For the interface lo-0/0/0/0, the passive setting is true, which means IS-IS will not send hello messages or LSPs on this interface.

```
set instance default protocol isis interface ifl-0/0/2/0 passive false
set instance default protocol isis interface ifl-0/0/2/0 level-1 snp-
authentication disable
set instance default protocol isis interface ifl-0/0/2/0 level-1 hello-
authentication disable
set instance default protocol isis interface ifl-0/0/2/1 flood-filter
spine1_lsr1_flood_filter
set instance default protocol isis interface ifl-0/0/2/1 type broadcast
set instance default protocol isis interface ifl-0/0/2/0 type point-to-point
set instance default protocol isis interface ifl-0/0/2/1 lsp-interval 200
set instance default protocol isis interface ifl-0/0/2/1 ldp-synchronization
enable
set instance default protocol isis interface ifl-0/0/2/1 level-1 snp-
authentication enable
set instance default protocol isis interface ifl-0/0/2/1 level-1 hello-
authentication enable
set instance default protocol isis interface ifl-0/0/2/1 level-1 metric 1000
set instance default protocol isis interface ifl-0/0/2/1 level-1 adjacency-disable
false
set instance default protocol isis interface ifl-0/0/2/1 level-1 priority 100
set instance default protocol isis interface ifl-0/0/2/1 level-1 hello-interval 20
set instance default protocol isis interface ifl-0/0/2/1 level-2 priority 100
set instance default protocol isis interface ifl-0/0/2/1 level-2 hello-interval 20
set instance default protocol isis interface lo-0/0/0/0 passive true
set instance default protocol isis interface lo-0/0/0/0 segment-routing ipv4 index
100
set instance default protocol isis interface lo-0/0/0/0 segment-routing ipv6 index
102
```

```
supervisor@rtbrick>spine1: cfg> show config instance default protocol isis
interface
{
  "rtbrick-config:interface": [
    {
      "name": "ifl-0/0/2/0",
      "type": "point-to-point",
      "passive": "false",
      "level-1": {
        "snp-authentication": "disable",
        "hello-authentication": "disable"
      },
      "level-2": {}
    },
    {
```

```
      "name": "ifl-0/0/2/1",
      "flood-filter": "spine1_lsr1_flood_filter",
      "type": "broadcast",
      "lsp-interval": 200,
      "ldp-synchronization": "enable",
      "level-1": {
        "snp-authentication": "enable",
        "hello-authentication": "enable",
        "metric": 1000,
        "adjacency-disable": "false",
        "priority": 100,
        "hello-interval": 20
      },
      "level-2": {
        "priority": 100,
        "hello-interval": 20
      }
    },
    {
      "name": "lo-0/0/0/0",
      "passive": "true",
      "segment-routing": {
        "ipv4": {
          "index": 100
        },
        "ipv6": {
          "index": 102
        }
      },
      "level-1": {},
      "level-2": {}
    }
  ]
}
```

Example: IS-IS Interface Level Flood Filter Configuration

This configuration sets a flood filter named 'spine1_lsr1_flood_filter' on the interface 'ifl-0/0/2/1' for S-IS protocol to control the flooding of routing updates.

```
set instance default protocol isis interface ifl-0/0/2/1 flood-filter
spine1_lsr1_flood_filter
```

```
supervisor@rtbrick>spine1: cfg> show config instance default protocol isis
interface ifl-0/0/2/1 flood-filter
{
  "rtbrick-config:flood-filter": "spine1_lsr1_flood_filter"
}
```

Example: IS-IS Interface Configuration with enabled LDP synchronization

```
set instance default protocol isis interface ifl-0/0/2/1 ldp-synchronization
```

```
enable
```

```
supervisor@rtbrick: cfg> show config instance default protocol isis interface ifl-
0/0/2/1 ldp-synchronization
{
  "rtbrick-config:ldp-synchronization": "enable"
}
```

Example: IS-IS Interface Configuration for a Broadcast Interface.

This configuration enables LDP synchronization on the interface 'ifl-0/0/2/1' for the default instance for the IS-IS routing protocol.

```
set instance default protocol isis interface ifl-0/0/2/1 ldp-synchronization
enable
```

```
supervisor@rtbrick>spine1: cfg> show config instance default protocol isis
interface ifl-0/0/2/1 type
{
  "rtbrick-config:type": "broadcast"
}
```

Example: P/E Flags Configuration for SID in IS-IS Segment Routing

```
set instance default protocol isis interface lo-0/0/0/1 segment-routing ipv4 no-
penultimate-pop true
```

The following command configures to assign an explicit null label for the penultimate router on the egress LSP. The configuration sets the 'lo-0/0/0/0' interface for the default IS-IS protocol instance. This interface is configured as passive for IS-IS and enables Segment Routing for both IPv4 and IPv6. The configuration includes assigning Segment Identifiers, enabling 'no-penultimate-pop' behavior, and advertising explicit null labels for both IPv4 and IPv6.

```
set instance default protocol isis interface lo-0/0/0/0 passive true
set instance default protocol isis interface lo-0/0/0/0 segment-routing ipv4 index
100
set instance default protocol isis interface lo-0/0/0/0 segment-routing ipv4 no-
penultimate-pop true
set instance default protocol isis interface lo-0/0/0/0 segment-routing ipv4
explicit-null true
set instance default protocol isis interface lo-0/0/0/0 segment-routing ipv6 index
106
Set instance default protocol isis interface lo-0/0/0/0 segment-routing ipv6 no-
penultimate-pop true
set instance default protocol isis interface lo-0/0/0/0 segment-routing ipv6
```

```
explicit-null true
```

```
supervisor@rtbrick.net: cfg> show config instance default protocol isis interface
lo-0/0/0/0
{
  "rtbrick-config:interface": [
    {
      "name": "lo-0/0/0/0",
      "passive": "true",
      "segment-routing": {
        "ipv4": {
          "index": 100,
          "no-penultimate-pop": "true",
          "explicit-null": "true"
        },
        "ipv6": {
          "index": 106,
          "no-penultimate-pop": "true",
          "explicit-null": "true"
        }
      }
    }
  ]
}
```

API To access the RESTCONF API that corresponds to this CLI, click here.

IS-IS Interface Level Configuration

Syntax:

set instance <instance> **protocol isis interface** <name> [**level-1** | **level-2**] <attribute> <value>

Attribute	Description
adjacency-disable [true/false]	Specify the level-1/level-2 adjacency on an interface. Default: false.
hello-authentication [disable/enable]	Authentication on hello packets.
hello-interval	Specifies the length of time between the sending of IS-IS hello PDUs. Default: 10. The hello interval can be set for both broadcast and point-to-point interfaces that are configured for Levels 1 and 2.

Attribute	Description
priority	Specify the priority on a broadcast interface. Default: 64.
metric <metric>	Level-1/Level-2 metric on an interface. Default: 1000000.
snp-authentication [enable/disable]	Authentication on CSNP/PSNP packets.

Example: IS-IS Interface Level Configuration

This configuration defines the parameters for the IS-IS interface 'ifl-0/0/2/1'. It includes various Level 1 and Level 2 parameters such as authentication for SNPs and hello messages, metrics, priorities, and hello intervals. It also defines the broadcast type, LSP intervals, and LDP synchronization.

For Level 1, snp-authentication and hello-authentication are enabled. The metric is set to 1000 or determining optimal paths. The adjacency-disable option is set to 'false', allowing Level 1 adjacencies. The priority is set to 100, and the hello-interval defines the interval for sending Level 1 Hello PDUs as 20 seconds.

For Level 2, the priority is also set to 100, influencing the Level 2 Designated Intermediate System (DIS) election, and the hello-interval is similarly set to 20 seconds for sending Level 2 Hello PDUs.

```
set instance default protocol isis interface ifl-0/0/2/1 flood-filter
spine1_lsr1_flood_filter
set instance default protocol isis interface ifl-0/0/2/1 type broadcast
set instance default protocol isis interface ifl-0/0/2/1 lsp-interval 200
set instance default protocol isis interface ifl-0/0/2/1 ldp-synchronization
enable
set instance default protocol isis interface ifl-0/0/2/1 level-1 snp-
authentication enable
set instance default protocol isis interface ifl-0/0/2/1 level-1 hello-
authentication enable
set instance default protocol isis interface ifl-0/0/2/1 level-1 metric 1000
set instance default protocol isis interface ifl-0/0/2/1 level-1 adjacency-disable
false
set instance default protocol isis interface ifl-0/0/2/1 level-1 priority 100
set instance default protocol isis interface ifl-0/0/2/1 level-1 hello-interval 20
set instance default protocol isis interface ifl-0/0/2/1 level-2 priority 100
set instance default protocol isis interface ifl-0/0/2/1 level-2 hello-interval 20
```

```
supervisor@rtbrick>spine1: cfg> show config instance default protocol isis
interface ifl-0/0/2/1
{
```

```
  "rtbrick-config:interface": [
    {
      "name": "ifl-0/0/2/1",
      "flood-filter": "spine1_lsr1_flood_filter",
      "type": "broadcast",
      "lsp-interval": 200,
      "ldp-synchronization": "enable",
      "level-1": {
        "snp-authentication": "enable",
        "hello-authentication": "enable",
        "metric": 1000,
        "adjacency-disable": "false",
        "priority": 100,
        "hello-interval": 20
      },
      "level-2": {
        "priority": 100,
        "hello-interval": 20
      }
    }
  ]
}
```


API To access the RESTCONF API that corresponds to this CLI, click here.

Interface-level Segment Routing Configuration

Syntax:

set instance <instance> **protocol isis interface** <name> **segment-routing** <attribute> <value>

Attribute	Description
segment-routing [ipv4 / ipv6] anycast-index <anycast-index>	Anycast index segment-ID. The prefix SIDs and anycast SIDs are applied on loopback interface only.
segment-routing [ipv4 / ipv6] index <index>	Prefix index segment ID.
segment-routing point-to-point [ipv4 / ipv6] adjacency-index <adjacency-index>	Adjacency index segment-ID. The adjacency SIDs are applied on active IS-IS interfaces on which adjacencies are established.

Example: IS-IS Interface Level Segment Routing Configuration for Prefix and Anycast SID

This configuration establishes IS-IS Interface Level Segment Routing for both IPv4 and IPv6 on two loopback interfaces. The interface 'lo-0/0/0' is assigned unique Segment Identifier indices: 100 for IPv4 and 200 for IPv6. These SIDs are utilized for prefix routing, allowing for the identification of specific network segments. Also, the loopback interface 'lo-0/0/1' is configured with anycast SID indices of 110 for IPv4 and 210 for IPv6. This configuration enables segment routing on both of the interfaces.

```
set instance default protocol isis interface lo-0/0/0
set instance default protocol isis interface lo-0/0/0 segment-routing ipv4
set instance default protocol isis interface lo-0/0/0 segment-routing ipv4 index
100
set instance default protocol isis interface lo-0/0/0 segment-routing ipv6
set instance default protocol isis interface lo-0/0/0 segment-routing ipv6 index
200
set instance default protocol isis interface lo-0/0/1 segment-routing ipv4
anycast-index 110
set instance default protocol isis interface lo-0/0/1 segment-routing ipv6
anycast-index 210
```

```
supervisor@rtbrick>spine1: cfg> show config instance default protocol isis
interface
{
  "rtbrick-config:instance": [
      {
        "name": "default",
        "protocol": {
          "isis": {
            "interface": [
              {
                "name": "lo-0/0/0",
                "segment-routing": {
                  "ipv4": {
                    "index": 100
                  },
                  "ipv6": {
                    "index": 200
                  }
                }
              },
              {
                "name": "lo-0/0/1",
                "segment-routing": {
                  "ipv4": {
                    "anycast-index": 110
                  },
                  "ipv6": {
                    "anycast-index": 210
                  }
                }
              }
            ]
          }
        }
```

```
      }
    ]
  }
}
```

Example: IS-IS Interface Level Segment Routing Configuration for Adjacency SID

This configuration establishes IS-IS Interface Level Segment Routing for both IPv4 and IPv6 on two loopback interfaces. The interface 'lo-0/0/0' is assigned unique Segment Identifier indices: 100 for IPv4 and 200 for IPv6. These SIDs are utilized for prefix routing. Also, the loopback interface 'lo-0/0/1' is configured with anycast SID indices '110', for IPv4 and 210 for IPv6. It enables segment routing on both of the interfaces.

```
set instance default protocol isis interface ifl-0/0/2/0
set instance default protocol isis interface ifl-0/0/2/0 segment-routing point-to-
point ipv4
set instance default protocol isis interface ifl-0/0/2/0 segment-routing point-to-
point ipv4 adjacency-index 111
set instance default protocol isis interface ifl-0/0/2/0 segment-routing point-to-
point ipv6
set instance default protocol isis interface ifl-0/0/2/0 segment-routing point-to-
point ipv6 adjacency-index 112
```

```
supervisor@rtbrick>spine1: cfg> show config instance default protocol isis
interface ifl-0/0/2/0 segment-routing
{
  "rtbrick-config:segment-routing": {
    "point-to-point": {
      "ipv4": {
        "adjacency-index": 111
      },
      "ipv6": {
        "adjacency-index": 112
      }
    }
  }
}
```

API To access the RESTCONF API that corresponds to this CLI, click here.

IS-IS Global Configuration

IS-IS Flood Filter Configuration

In IS-IS, by default all routers flood link-state packets, so that all routers will have a complete topology view. IS-IS flood filters allow to modify this behavior and limit the exchange of LSPs. For example, if two spine routers in a spine/leaf fabric are

symmetrically connected to two upstream label-switch routers (LSR) like shown in the figure below, you can use a flood filter to not advertise LSPs learned from LSR A back to the LSR B via the second spine switch.

The flooding filter configuration is part of the global configuration hierarchy and therefore you can configure filtering globally, i.e. not per instance, so that the filter configurations can be reused across instances.

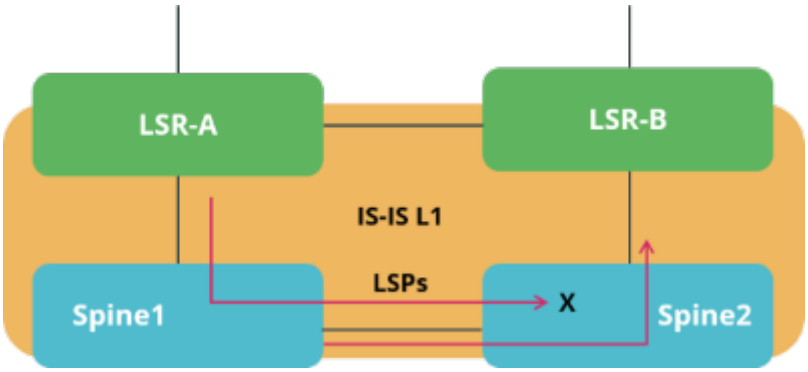


Figure 15. IS-IS Flood Filter Configuration

Syntax:

set global protocol isis flood-filter <filter-name> <ordinal> <attribute> <value>

Attribute	Description
<filter-name>	Filter-name which binds a flooding filter to an IS-IS interface
<ordinal>	Number to filter rule
action [block/flood]	Action required to flood or not
ordinal-name <ordinal-name>	Name for the filter rule
system-id <system-id>	IS-IS instance system-id
system-id-mask <system-id-mask>	System ID mask on which the filter should match

Example: IS-IS Flood Filter Configuration

This configuration sets up a flood filter named 'spine1_lsr1_flood_filter' for the

interface 'ifl-0/0/2/1'.

```
set instance default protocol isis interface ifl-0/0/2/1 flood-filter flood-filter
spine1_lsr1_flood_filter
```

```
supervisor@rtbrick>spine1: cfg> show config instance default protocol isis
interface ifl-0/0/2/1 flood-filter
{
  "rtbrick-config:flood-filter": "spine1_lsr1_flood_filter"
}
```

Level 2 to Level 1 Policy Configuration

The policy configuration allows to define a policy for leaking all the level 2 routes to level 1.

For more information about Policy configuration, see the Policy User Guide.

Syntax:

set policy statement isis_l2tol1_leak ordinal <value> **action rule** <value> **operation return-permit**

Attribute	Description
ordinal <value>	Specifies the ordinal value.
rule <number>	Specify the action rule number.
operation return-permit	Stops policy execution and return result as permit.

The following configuration defines a routing policy named 'isis_l2tol1_leak' that permits all routes to be leaked from IS-IS Level 2 into Level 1. The policy contains a rule (ordinal 1) with an action to 'return-permit'. Since no specific prefixes are matched, the permit action applies to all routes by default. This configuration allows all Level 2 routes to be leaked into Level 1 routers.

```
set policy statement isis_l2tol1_leak
set policy statement isis_l2tol1_leak ordinal 1
set policy statement isis_l2tol1_leak ordinal 1 action
set policy statement isis_l2tol1_leak ordinal 1 action rule 1
set policy statement isis_l2tol1_leak ordinal 1 action rule 1 operation return-
permit
```

```
supervisor@rtbrick.net: cfg> show config policy
{
  "rtbrick-config:policy": {
    "statement": [
      {
        "name": "isis_l2tol1_leak",
        "ordinal": [
          {
            "ordinal": 1,
            "action": {
              "rule": [
                {
                  "rule": 1,
                  "operation": "return-permit"
                }
              ]
            }
          }
        ]
      }
    ]
  }
}
```

Level 2 to Level 1 Policy Configuration for a Specific IPv4 Route

The policy configuration allows to define a policy for leaking a specific IPv4 level 2 routes to level 1.

For more information about Policy configuration, see the Policy User Guide.

Syntax:

set policy statement <policy-name> **ordinal** <number> **match rule** <number> <attribute> <value>

Attribute	Description
rule <number>	Specifies the match rule number.
type <attribute-type>	Specifies the attribute type.
match-type <match-type>	Specifies the match type.
value <value>	Attribute value. This is the actual value of the attribute to match, for example an IP prefix.
value-type <value-type>	Attribute value type.

The following policy configuration allows only a specific IPv4 route to be leaked from level2 to level1 and blocking the other level2 route leaking to level1. It defines a routing policy named 'isis_l2tol1_leak' that controls which IS-IS Level 2 routes are leaked into Level 1. The rule 'ordinal 1' matches the exact IPv4 prefix 192.168.1.3/32 and allows it to be leaked from Level 2 to Level 1. The second rule 'ordinal 10' is as a default deny (return-deny), preventing any other prefixes from being leaked. This ensures only the explicitly defined route is distributed to Level 1 routers. The policy contains rules to leak a specific route to Level 1 routers and to deny all other routes from leaking.

```
set policy statement isis_l2tol1_leak
set policy statement isis_l2tol1_leak ordinal 1
set policy statement isis_l2tol1_leak ordinal 1 match
set policy statement isis_l2tol1_leak ordinal 1 match rule 1
set policy statement isis_l2tol1_leak ordinal 1 match rule 1 type ipv4-prefix
set policy statement isis_l2tol1_leak ordinal 1 match rule 1 value-type discrete
set policy statement isis_l2tol1_leak ordinal 1 match rule 1 match-type exact
set policy statement isis_l2tol1_leak ordinal 1 match rule 1 value 192.168.1.3/32
set policy statement isis_l2tol1_leak ordinal 1 action
set policy statement isis_l2tol1_leak ordinal 1 action rule 1
set policy statement isis_l2tol1_leak ordinal 1 action rule 1 operation return-
permit
set policy statement isis_l2tol1_leak ordinal 10
set policy statement isis_l2tol1_leak ordinal 10 action
set policy statement isis_l2tol1_leak ordinal 10 action rule 1
set policy statement isis_l2tol1_leak ordinal 10 action rule 1 operation return-
deny
```

```
supervisor@rtbrick.net: cfg> show config policy
{
  "rtbrick-config:policy": {
    "statement": [
      {
        "name": "isis_l2tol1_leak",
        "ordinal": [
          {
            "ordinal": 1,
            "match": {
              "rule": [
                {
                  "rule": 1,
                  "type": "ipv4-prefix",
                  "value-type": "discrete",
                  "match-type": "exact",
                  "value": [
                    "192.168.1.3/32"
                    ]
                }
              ]
            },
            "action": {
              "rule": [
                {
```

```
                  "rule": 1,
                  "operation": "return-permit"
                }
              ]
            }
          },
          {
            "ordinal": 10,
            "action": {
              "rule": [
                {
                  "rule": 1,
                  "operation": "return-deny"
                }
              ]
            }
          }
        ]
      }
    ]
  }
}
```

IS-IS Level 2 to Level 1 Route Leaking Configuration

This configuration associates level2 to level1 route leaking policy with the IS-IS instance.



Level 2 to Level 1 route leaking policy must be created prior to referencing it to the IS-IS instance.

Syntax:

set instance <instance-name> **protocol isis level2-to-level1 route-leak policy** <name>

Attribute	Description
<instance-name>	Specifies the name of the instance.
policy-name	Specify name of the route leak policy.

Example: IS-IS Level 2 to Level 1 Route Leaking Configuration

This following configuration enables route leaking from IS-IS Level 2 to Level 1 within the default routing instance. It allows specific Level 2 routes to be advertised into the Level 1 area using the defined route policy 'isis_l2tol1_leak'. The policy determines which routes are eligible for leaking and provides controlled

redistribution between IS-IS levels for improved reachability.

```
set instance default protocol isis level2-to-level1 route-leak policy
isis_l2tol1_leak
```

```
supervisor@rtbrick.net: cfg> show config instance default protocol isis level2-to-
level1
{
  "rtbrick-config:level2-to-level1": {
    "route-leak": {
      "policy": [
        "isis_l2tol1_leak"
        ]
    }
  }
}
```

2.6.3. IS-IS Operational Commands

IS-IS Show Commands

The IS-IS show commands provide detailed information about the IS-IS protocol operation and IS-IS routes.

IS-IS Overview

Syntax:

show isis overview

Option	Description
-	Without any option, this command displays a summary of all the IS-IS instances

Example: Summary view of all the IS-IS instances

```
supervisor@rtbrick>spine1: op> show isis overview
Instance: default
  System ID: 1921.6800.1001
  System hostname: isr1
  Areas: 49.0001/24
  Neighbor hold time: 30 sec
  LSP life time: 65535 sec
  Overload bit set: False
  SRGB base: 1000
  SRGB range: 1000
```

```
  SRGB label values: 1000 - 1999
  SRLB base: 2000
  SRLB range: 1000
  SRLB label values: 2000 - 2999
  Authentication: Level 1: md5, Level 2: md5
```

API To access the Operational State API that corresponds to this CLI, click include::common:partial$operational_api_links.adoc[tag=show_isis_overview].

IS-IS Interface

Syntax:

show isis interface <option>

Option	Description
-	Without any option, this command displays a summary of all the IS-IS interfaces
instance	Displays IS-IS interface information for an instance
statistics	Displays IS-IS interface statistics information
detail	Displays detailed output for all interfaces.

Example 1: Summary view of the IS-IS interfaces

```
supervisor@rtbrick>spine1: op> show isis interface
Instance: default
  Interface      Level   Adjacencies    Metric     Type            Passive  LDP-
sync
  lo-0/0/0/0         1             0    1000000    loopback              1  -
  lo-0/0/0/0         2             0    1000000    loopback              1  -
  ifl-0/0/2/0        2             1    1000000    point-to-point        0  -
  ifl-0/0/2/1        1             2    1000000    broadcast             0  -
  ifl-0/0/2/1        2             2    1000000    broadcast             0  -
```

Example 2: Summary view of the IS-IS interfaces for a specific instance

```
supervisor@rtbrick>spine1: op> show isis interface instance default
Instance: default
  Interface      Level   Adjacencies  Metric     Type            Passive  LDP-sync
  lo-0/0/0/0         1             0  1000000    loopback              1  -
  lo-0/0/0/0         2             0  1000000    loopback              1  -
  ifl-0/0/2/0        2             1  1000000    point-to-point        0  -
  ifl-0/0/2/1        1             2  1000000    broadcast             0  -
```

```
  ifl-0/0/2/1        2             2  1000000    broadcast             0  -
```

Example 3: Summary view of the IS-IS interfaces for a specific interface

```
supervisor@rtbrick>spine1: op> show isis interface ifl-0/0/2/0
Instance: default
  Interface: ifl-0/0/2/0, Level: 1
    Type: point-to-point, Passive: False
    Metric: 1000000
    Hello interval: 10 seconds, Hello multiplier: 3, Hold time: 30 seconds
    Adjacencies: 1
    CNSP in: 0, CNSP out: 2446, CNSP success: 1222, CNSP fail: 0
    PSNP in: 0, PSNP out: 0, PSNP success: 0, PSNP fail: 0
    LSP in: 0, LSP out: 0, LSP success: 0, LSP fail: 0, LSP in purge: 0 LSP in
auth fail: 0
    IIH in: 1134, IIH out: 1138
  Interface: ifl-0/0/2/0, Level: 2
    Type: point-to-point, Passive: False
    Metric: 1000000
    Hello interval: 10 seconds, Hello multiplier: 3, Hold time: 30 seconds
    Adjacencies: 1
    CNSP in: 0, CNSP out: 2446, CNSP success: 1222, CNSP fail: 0
    PSNP in: 0, PSNP out: 0, PSNP success: 0, PSNP fail: 0
    LSP in: 0, LSP out: 0, LSP success: 0, LSP fail: 0, LSP in purge: 0 LSP in
auth fail: 0
    IIH in: 1134, IIH out: 1138
```

Example 4: Summary view of the IS-IS interface statistics

```
supervisor@rtbrick>spine1: op> show isis interface statistics
Instance: default
  Interface     Level  CSNP In  CSNP Out  CSNP Fail  PSNP In  PSNP Out  PSNP Fail  LSP In  LSP Out  LSP Fail
IIH In  IIH Out
  lo-0/0/0/0        1        0         0          0        0         0          0       0        0         0
0        0
  lo-0/0/0/0        2        0         0          0        0         0          0       0        0         0
0        0
  ifl-0/0/2/0       1        0      2454          0        0         0          0       0        0         0
1138     1142
  ifl-0/0/2/0       2        0      2454          0        0         0          0       0        0         0
1138     1142
  ifl-0/0/2/1       1        0         0          0        0         0          0       3        1         0
2288     2285
  ifl-0/0/2/1       2        0         0          0        0         0          0       4        1         0
2288     2285
```

Example 5: Detailed output of the IS-IS interface

```
supervisor@rtbrick>spine1: op> show isis interface detail
Instance: default
  Interface: lo-0/0/0/0, Level: 1
    Type: loopback, Passive: True
    Metric: 1000000
    Hello interval: 10 seconds, Hello multiplier: 3, Hold time: 30 seconds
    Adjacencies: 0
    CNSP in: 0, CNSP out: 0, CNSP success: 0, CNSP fail: 0
    PSNP in: 0, PSNP out: 0, PSNP success: 0, PSNP fail: 0
```

```
    LSP in: 0, LSP out: 0, LSP success: 0, LSP fail: 0, LSP in purge: 0 LSP in
auth fail: 0
    IIH in: 0, IIH out: 0
  Interface: lo-0/0/0/0, Level: 2
    Type: loopback, Passive: True
    Metric: 1000000
    Hello interval: 10 seconds, Hello multiplier: 3, Hold time: 30 seconds
    Adjacencies: 0
    CNSP in: 0, CNSP out: 0, CNSP success: 0, CNSP fail: 0
    PSNP in: 0, PSNP out: 0, PSNP success: 0, PSNP fail: 0
    LSP in: 0, LSP out: 0, LSP success: 0, LSP fail: 0, LSP in purge: 0 LSP in
auth fail: 0
    IIH in: 0, IIH out: 0
Instance: default
  Interface: ifl-0/0/2/0, Level: 1
    Type: point-to-point, Passive: False
    Metric: 1000000
    Hello interval: 10 seconds, Hello multiplier: 3, Hold time: 30 seconds
    Adjacencies: 1
    CNSP in: 0, CNSP out: 2460, CNSP success: 1229, CNSP fail: 0
    PSNP in: 0, PSNP out: 0, PSNP success: 0, PSNP fail: 0
    LSP in: 0, LSP out: 0, LSP success: 0, LSP fail: 0, LSP in purge: 0 LSP in
auth fail: 0
    IIH in: 1141, IIH out: 1145
  Interface: ifl-0/0/2/0, Level: 2
    Type: point-to-point, Passive: False
    Metric: 1000000
    Hello interval: 10 seconds, Hello multiplier: 3, Hold time: 30 seconds
    Adjacencies: 1
    CNSP in: 0, CNSP out: 2460, CNSP success: 1229, CNSP fail: 0
    PSNP in: 0, PSNP out: 0, PSNP success: 0, PSNP fail: 0
    LSP in: 0, LSP out: 0, LSP success: 0, LSP fail: 0, LSP in purge: 0 LSP in
auth fail: 0
    IIH in: 1141, IIH out: 1145
 <...>
```

Example 6: Detailed output of an IS-IS interface that supports broadcast

```
supervisor@rtbrick>spine1: op> show isis interface ifl-0/0/2/1
Instance: default
  Interface: ifl-0/0/2/1, Level: 1
    Type: broadcast, Passive: False, Circuit ID: 0x1
    Metric: 1000000, Priority: 64
    Hello interval: 10 seconds, Hello multiplier: 3, Hold time: 30 seconds
    Designated IS: isr6.01(1921.6800.1006.01)
    Adjacencies: 2
    CNSP in: 0, CNSP out: 0, CNSP success: 1238, CNSP fail: 0
    PSNP in: 0, PSNP out: 0, PSNP success: 0, PSNP fail: 0
    LSP in: 3, LSP out: 1, LSP success: 3, LSP fail: 0, LSP in purge: 0 LSP in
auth fail: 0
    IIH in: 2304, IIH out: 2301
  Interface: ifl-0/0/2/1, Level: 2
    Type: broadcast, Passive: False, Circuit ID: 0x1
    Metric: 1000000, Priority: 64
    Hello interval: 10 seconds, Hello multiplier: 3, Hold time: 30 seconds
    Designated IS: isr6.01(1921.6800.1006.01)
    Adjacencies: 2
    CNSP in: 0, CNSP out: 0, CNSP success: 1238, CNSP fail: 0
    PSNP in: 0, PSNP out: 0, PSNP success: 0, PSNP fail: 0
```

```
    LSP in: 4, LSP out: 1, LSP success: 4, LSP fail: 0, LSP in purge: 0 LSP in
auth fail: 0
    IIH in: 2304, IIH out: 2301
```

API To access the Operational State API that corresponds to this CLI, click include::common:partial$operational_api_links.adoc[tag=show_isis_interface].

IS-IS Neighbor

Syntax:

show isis neighbor <option>

Option	Description
-	Without any option, this command displays a summary of all the IS-IS neighbors
detail	Displays detailed information for IS-IS neighbor
instance	Displays IS-IS neighbor information for an instance

Example 1: Summary view of the IS-IS neighbor

```
supervisor@rtbrick>spine1: op> show isis neighbor
Instance: default
  Interface        System       Level   State   Type       Up since
Expires
  ifl-0/0/2/0        isr6         L1L2    Up      P2P        Thu Jul 25 05:40:05
in 18s 750197us
  ifl-0/0/2/1        isr6         L1      Up      Broadcast  Thu Jul 25 05:39:58
in 26s 728457us
  ifl-0/0/2/1        isr6         L2      Up      Broadcast  Thu Jul 25 05:39:58
in 29s 729531us
```

Example 2: Detailed view of the IS-IS neighbor

```
supervisor@S1-STD-17-1703: cfg> show isis neighbor detail
Instance: default
  System: isr6, Interface: ifl-0/0/2/0
    State: Up, Level: L1L2, Adjacency type: P2P
    Hold time: 30.0s, Expiry time: in 29s 780091us
    Local IPv4 address: 16.0.1.1, Remote IPv4 address: 16.0.1.6, Unnumbered: False
    Local IPv6 address: fe80::7807:2dff:fec0:2, Remote IPv6 address:
fe80::7847:eff:fec0:0
    Up since: Thu Jul 25 05:40:05 GMT +0000 2024, Last down reason: NA
    Last transition: 2024-07-25T05:40:05.778348+0000, Number of transitions: 2
    Error counters:
```

```
      Level mismatch: 0, Area mismatch: 0, System ID: 0, Subnet mismatch: 0
      Hold timeout: 0, Neighbor down: 0, Interface down: 0, Admin reset: 0
      Interface configuration: 0, Area configuration: 0, Other: 0
  System: isr6, Interface: ifl-0/0/2/1
    State: Up, Level: L1L2, Adjacency type: Broadcast
    Hold time: 30.0s, Expiry time: in 24s 779280us
    Priority: 64, Designated IS: 1921.6800.1006.01, SNPA: 7a:47:0e:c0:00:00
    Local IPv4 address: 16.0.2.1, Remote IPv4 address: 16.0.2.6, Unnumbered: False
    Local IPv6 address: fe80::7807:2d00:1c0:2, Remote IPv6 address:
fe80::7847:e00:1c0:0
    Up since: Thu Jul 25 05:39:58 GMT +0000 2024, Last down reason: NA
    Last transition: 2024-07-25T05:39:58.725007+0000, Number of transitions: 3
    Error counters:
      Level mismatch: 0, Area mismatch: 0, System ID: 0, Subnet mismatch: 0
      Hold timeout: 0, Neighbor down: 0, Interface down: 0, Admin reset: 0
      Interface configuration: 0, Area configuration: 0, Other: 0
<...>
```

Example 3: Summary view of the IS-IS neighbor for the specified instance

```
supervisor@rtbrick>spine1: op> show isis neighbor instance default
Instance: default
  Interface      System      Level   State   Type       Up since
Expires
  ifl-0/0/2/0    isr6        L1L2    Up      P2P        Thu Jul 25 05:40:05    in
21s 893028us
  ifl-0/0/2/1    isr6        L1      Up      Broadcast  Thu Jul 25 05:39:58    in
26s 848320us
  ifl-0/0/2/1    isr6        L2      Up      Broadcast  Thu Jul 25 05:39:58    in
24s 845934us
supervisor@rtbrick>spine1: op>
```

Example 4: Detailed view of the IS-IS neighbor for the specified instance

```
supervisor@rtbrick>spine1: op> show isis neighbor instance default detail
Instance: default
  System: isr6, Interface: ifl-0/0/2/0
    State: Up, Level: L1L2, Adjacency type: P2P
    Hold time: 30.0s, Expiry time: in 21s 155501us
    Local IPv4 address: 16.0.1.1, Remote IPv4 address: 16.0.1.6, Unnumbered: False
    Local IPv6 address: fe80::7807:2dff:fec0:2, Remote IPv6 address:
fe80::7847:eff:fec0:0
    Up since: Thu Jul 25 05:40:05 GMT +0000 2024, Last down reason: NA
    Last transition: 2024-07-25T05:40:05.778348+0000, Number of transitions: 2
    Error counters:
      Level mismatch: 0, Area mismatch: 0, System ID: 0, Subnet mismatch: 0
      Hold timeout: 0, Neighbor down: 0, Interface down: 0, Admin reset: 0
      Interface configuration: 0, Area configuration: 0, Other: 0
  System: isr6, Interface: ifl-0/0/2/1
    State: Up, Level: L1L2, Adjacency type: Broadcast
    Hold time: 30.0s, Expiry time: in 23s 150249us
    Priority: 64, Designated IS: 1921.6800.1006.01, SNPA: 7a:47:0e:c0:00:00
    Local IPv4 address: 16.0.2.1, Remote IPv4 address: 16.0.2.6, Unnumbered: False
    Local IPv6 address: fe80::7807:2d00:1c0:2, Remote IPv6 address:
fe80::7847:e00:1c0:0
    Up since: Thu Jul 25 05:39:58 GMT +0000 2024, Last down reason: NA
```

```
    Last transition: 2024-07-25T05:39:58.725007+0000, Number of transitions: 3
    Error counters:
      Level mismatch: 0, Area mismatch: 0, System ID: 0, Subnet mismatch: 0
      Hold timeout: 0, Neighbor down: 0, Interface down: 0, Admin reset: 0
      Interface configuration: 0, Area configuration: 0, Other: 0
 <...>
```

Example 5: Detailed view of the Unnumbered IS-IS Neighbor

```
supervisor@rtbrick: cfg> show isis neighbor detail
Instance: service
  System: isr2, Interface: ifl-0/0/25/0
    State: Up, Level:L1L2, Adjacency type: P2P
    Circuit type: L1L2, Hold time: 30.0s, Expiry time: in 27s 214928us
    Local IPv4 address: 192.0.2.1, Remote IPv4 address: 192.0.2.2, Unnumbered:
True
    Local IPv6 address: fe80::7818:800:c0:0, Remote IPv6 address:
fe80::7866:3200:c0:0
    Up since: Wed Jul 09 05:31:05 GMT +0000 2025, Last down reason: NA
    Last transition: 2025-07-09T05:31:05.296130+0000, Number of transitions: 2
    Error counters:
      Level mismatch: 0, Area mismatch: 0, System ID: 0, Subnet mismatch: 0
      Hold timeout: 0, Neighbor down: 0, Interface down: 0, Admin reset: 0
      Interface configuration: 0, Area configuration: 0, Other: 0
  System: isr2, Interface: ifl-0/0/25/1
    State: Up, Level:L1L2, Adjacency type: P2P
    Circuit type: L1L2, Hold time: 30.0s, Expiry time: in 27s 214802us
    Local IPv4 address: 192.0.2.1, Remote IPv4 address: 192.0.2.2, Unnumbered:
True
    Local IPv6 address: fe80::7818:800:1c0:0, Remote IPv6 address:
fe80::7866:3200:1c0:0
    Up since: Wed Jul 09 05:31:05 GMT +0000 2025, Last down reason: NA
    Last transition: 2025-07-09T05:31:05.296777+0000, Number of transitions: 2
    Error counters:
      Level mismatch: 0, Area mismatch: 0, System ID: 0, Subnet mismatch: 0
      Hold timeout: 0, Neighbor down: 0, Interface down: 0, Admin reset: 0
      Interface configuration: 0, Area configuration: 0, Other: 0
```

 To access the Operational State API that corresponds to this CLI, click include::common:partial$operational_api_links.adoc[tag=show_isis_neighbor].

Designated IS (DIS) Election History

In IS-IS broadcast networks, the Designated Intermediate System (DIS) is elected to optimize the distribution of routing information, reducing network overhead by coordinating the flooding of Link State Packets (LSPs) among multiple routers. This ensures efficient and stable network operation. The following command displays the DIS election history in RBFS.

Syntax:

show isis dis-election history <attribute> <value>

Option	Description
-	Without any option, this command displays a summary of all the IS-IS.
instance	Displays DIS history information for the specified instance.
interface <interface-name>	Displays IS-IS DIS history information for the specified interface.
level [level-1/level-2]	Displays IS-IS DIS history information for the specified level.

Example: Summary view of IS-IS DIS Election History

```
supervisor@rtbrick>spine1: op> show isis dis-election history
Instance: default, Interface: ifl-0/0/2/1, Level: 1
Timestamp                           DIS                     Event
Thu Jul 25 05:39:58 GMT +0000 2024     -                    Neighbour
1921.6800.1006 adjacency state changed from Init to Up
Thu Jul 25 05:39:58 GMT +0000 2024    1921.6800.1006.01     Neighbour
1921.6800.1006 DIS changed from 0000.0000.0000.00 to 1921.6800.1006.01
Instance: default, Interface: ifl-0/0/2/1, Level: 2
Timestamp                           DIS                     Event
Thu Jul 25 05:39:58 GMT +0000 2024     -                    Neighbour
1921.6800.1006 adjacency state changed from Init to Up
Thu Jul 25 05:39:58 GMT +0000 2024    1921.6800.1006.01     Neighbour
1921.6800.1006 DIS changed from 0000.0000.0000.00 to 1921.6800.1006.01
```

IS-IS Hostname

Syntax:

show isis hostname

Option	Description
-	Without any option, this command displays a summary of all the IS-IS dynamic hostnames

Example: Summary view of IS-IS hostnames

```
supervisor@rtbrick>spine1: op> show isis hostname
Instance       System-ID           Hostname
default        1921.6800.1001      isr1
default        1921.6800.1006      isr6
default        1921.6800.1006      isr6
supervisor@rtbrick>spine1: op>
```

IS-IS Database

Syntax:

show isis database <option>

Option	Description
-	Without any option, this command displays all the IS-IS databases
detail	Displays detailed information for IS-IS database
instance	Displays IS-IS database information for an instance
lsp <lsp_name>	Displays a summary of IS-IS database for the specified LSP name.
lsp id <lsp-id>	Displays a summary of IS-IS database for the specified LSP ID.
[level-1/level-2] lsp	Displays a summary of IS-IS database LSP information for specified level
system <system-id>	Displays a summary of IS-IS database for all LSPs from a system
[level-1/level-2] system	Displays a summary of IS-IS database for all LSPs from a system on the specified level.
[level-1/level-2] detail	Displays detailed information for the specified level

Example 1: Summary view of the IS-IS Database

```
supervisor@S1-STD-7-7001>bm01-tst.fsn.rtbrick.net: op> show isis database
Instance: default, Level: 1
  LSP ID                  Sequence     Checksum     Lifetime     Overload     Attached
  isr1.00-00                   0x4        0xe035        52785            0            0
  isr6.00-00                   0x3        0xe281        52785            0            0
  isr6.01-00                   0x1        0x4b1a        52778            0            0
Instance: default, Level: 2
```

```
  LSP ID                  Sequence     Checksum     Lifetime     Overload     Attached
  isr1.00-00                   0x6       0x75af        52785            0            0
  isr6.00-00                   0x5       0x117e        52785            0            0
  isr6.01-00                   0x1       0x4b1a        52778            0            0
```

Example 2: Summary view of the IS-IS database for the specified LSP

```
supervisor@rtbrick>spine1: op> show isis database lsp id 1921.6800.1002.00-00
Instance: default, Level: 1
  LSP ID: isr2.00-00
    Interface:
    LSP Header:
      Sequence: 0x2a
      Checksum: 0x2ec8
      Remaining lifetime: 65535 seconds
      Flags: Attached: 1, Overload: 0
    Packet:
      Length: 399 bytes
      Last received time: 2026-01-08T08:38:44.465451+0000
      Expiry: expires in 18h 8m 38s 364766us
    System ID: 1921.6800.1002
    Dynamic Hostname TLV (137): isr2
    Protocols Supported TLVs (129):
      Network layer protocol ID: IPv6
      Network layer protocol ID: IPv4
    Area Address TLVs (1):
      Area address: 49.0001
    Authentication TLV (10):
      Type: md5
      Value: 70d1fe3c638f8759c4d74422336168e5
    IS Reachability TLVs (22):
      IS neighbor: 1921.6800.1001.00              Metric:  1000000
      IS neighbor: 1921.6800.1001.00              Metric:  1000000
      IS neighbor: 1921.6800.1002.01              Metric:  1000000
      IS neighbor: 1921.6800.1002.02              Metric:  1000000
      IS neighbor: 1921.6800.1005.00              Metric:  1000000
      IS neighbor: 1921.6800.1006.00              Metric:  1000000
    IPv4 Reachability TLVs (135):
      IPv4 prefix: 11.0.0.0/24                    Metric:  1000000   Internal   Up
      IPv4 prefix: 12.0.1.0/24                    Metric:  1000000   Internal   Up
      IPv4 prefix: 12.0.2.0/24                    Metric:  1000000   Internal   Up
      IPv4 prefix: 12.1.1.0/24                    Metric:  1000000   Internal   Up
      IPv4 prefix: 23.0.1.0/24                    Metric:  1000000   Internal   Up
      IPv4 prefix: 23.0.2.0/24                    Metric:  1000000   Internal   Up
      IPv4 prefix: 24.0.1.0/24                    Metric:  1000000   Internal   Up
      IPv4 prefix: 25.0.1.0/24                    Metric:  1000000   Internal   Up
      IPv4 prefix: 26.0.1.0/24                    Metric:  1000000   Internal   Up
      IPv4 prefix: 182.168.1.2/32                 Metric:  1000000   Internal   Up
      IPv4 prefix: 192.168.1.2/32                 Metric:  1000000   Internal
 <...>
```

Example 3: Detailed view of the IS-IS database for level-1

```
supervisor@rtbrick>spine1: op> show isis database level-1 detail
Instance: default, Level: 1
  LSP ID: isr1.00-00
```

```
    Interface:
    LSP Header:
      Sequence: 0x4
      Checksum: 0xe035
      Remaining lifetime: 52682 seconds
      Flags: Attached: 0, Overload: 0
    Packet:
      Length: 182 bytes
      Last received time: 2024-07-25T05:40:05.989755+0000
      Expiry: expires in 14h 38m 2s 951316us
    System ID: 1921.6800.1001
    Dynamic Hostname TLV (137): isr1
    Protocols Supported TLVs (129):
      Network layer protocol ID: IPv6
      Network layer protocol ID: IPv4
    Area Address TLVs (1):
      Area address: 49.0001
    IS Reachability TLVs (22):
      IS neighbor: 1921.6800.1006.00              Metric:  1000000,
      IS neighbor: 1921.6800.1006.01              Metric:  1000000,
    IPv4 Reachability TLVs (135):
      IPv4 prefix: 16.0.1.0/24                    Metric:  1000000   Internal   Up
      IPv4 prefix: 16.0.2.0/24                    Metric:  1000000   Internal   Up
      IPv4 prefix: 192.168.1.1/32                 Metric:  1000000   Internal   Up
SID:  100   Flags: Node
    IPv6 Reachability TLVs (236):
      IPv6 prefix: 16:0:1::/64                    Metric:  1000000   Internal   Up
      IPv6 prefix: 16:0:2::/64                    Metric:  1000000   Internal   Up
      IPv6 prefix: 192:168:1::1/128               Metric:  1000000   Internal   Up
SID:  102   Flags: Node
    Segment Routing TLVs (242/sub 2):
      SRGB: Base: 1000, Range: 1000, Router ID: 192.168.1.1
  LSP ID: isr6.00-00
    Interface: ifl-0/0/2/1
    LSP Header:
      Sequence: 0x3
      Checksum: 0xe281
      Remaining lifetime: 52682 seconds
      Flags: Attached: 0, Overload: 0
    Packet:
      Length: 182 bytes
      Last received time: 2024-07-25T05:40:05.786957+0000
      Expiry: expires in 14h 38m 2s 748444us
    System ID: 1921.6800.1006
    Dynamic Hostname TLV (137): isr6
    Protocols Supported TLVs (129):
      Network layer protocol ID: IPv6
      Network layer protocol ID: IPv4
    Area Address TLVs (1):
      Area address: 49.0001
    IS Reachability TLVs (22):
      IS neighbor: 1921.6800.1001.00              Metric:  1000000,
      IS neighbor: 1921.6800.1006.01              Metric:  1000000,
    IPv4 Reachability TLVs (135):
      IPv4 prefix: 16.0.1.0/24                    Metric:  1000000   Internal   Up
      IPv4 prefix: 16.0.2.0/24                    Metric:  1000000   Internal   Up
      IPv4 prefix: 192.168.1.6/32                 Metric:  1000000   Internal   Up
SID:  600   Flags: Node
    IPv6 Reachability TLVs (236):
      IPv6 prefix: 16:0:1::/64                    Metric:  1000000   Internal   Up
      IPv6 prefix: 16:0:2::/64                    Metric:  1000000   Internal   Up
```

```
      IPv6 prefix: 192:168:1::6/128               Metric:  1000000   Internal   Up
SID:  601   Flags: Node
    Segment Routing TLVs (242/sub 2):
      SRGB: Base: 6000, Range: 1000, Router ID: 192.168.1.6
 <...>
```

Example 4: Summary view of the IS-IS database for the specified instance

```
supervisor@rtbrick>spine1: op> show isis database instance default
Instance: default, Level: 1
  LSP ID                    Sequence     Checksum     Lifetime     Overload     Attached
  isr1.00-00                     0x4        0xe035        52625            0            0
  isr6.00-00                     0x3        0xe281        52625            0            0
  isr6.01-00                     0x1        0x4b1a        52618            0            0
Instance: default, Level: 2
  LSP ID                    Sequence     Checksum     Lifetime     Overload     Attached
  isr1.00-00                     0x6        0x75af        52625            0            0
  isr6.00-00                     0x5        0x117e        52625            0            0
  isr6.01-00                     0x1        0x4b1a        52618            0            0
```

Example 5: Summary view of the IS-IS database for the specified instance and LSP

```
supervisor@rtbrick>spine1: op> show isis database instance default lsp id
1921.6800.1001.00-00
Instance: default, Level: 1
  LSP ID: isr1.00-00
    Interface:
    LSP Header:
      Sequence: 0x4
      Checksum: 0xe035
      Remaining lifetime: 65535 seconds
      Flags: Attached: 0, Overload: 0
    Packet:
      Length: 182 bytes
      Last received time: 2024-07-25T05:40:05.989755+0000
      Expiry: expires in 14h 36m 35s 357028us
    System ID: 1921.6800.1001
    Dynamic Hostname TLV (137): isr1
    Protocols Supported TLVs (129):
      Network layer protocol ID: IPv6
      Network layer protocol ID: IPv4
    Area Address TLVs (1):
      Area address: 49.0001
    IS Reachability TLVs (22):
      IS neighbor: 1921.6800.1006.00              Metric:  1000000
      IS neighbor: 1921.6800.1006.01              Metric:  1000000
    IPv4 Reachability TLVs (135):
      IPv4 prefix: 16.0.1.0/24                    Metric:  1000000   Internal   Up
      IPv4 prefix: 16.0.2.0/24                    Metric:  1000000   Internal   Up
      IPv4 prefix: 192.168.1.1/32                 Metric:  1000000   Internal   Up
SID:  100   Flags: Node
    IPv6 Reachability TLVs (236):
      IPv6 prefix: 16:0:1::/64                    Metric:  1000000   Internal   Up
      IPv6 prefix: 16:0:2::/64                    Metric:  1000000   Internal   Up
      IPv6 prefix: 192:168:1::1/128               Metric:  1000000   Internal   Up
SID:  102   Flags: Node
    Segment Routing TLVs (242/sub 2):
```

```
      SRGB: Base: 1000, Range: 1000, Router ID: 192.168.1.1
 <...>
```

IS-IS Route

Syntax:

show isis route <option>

Option	Description
-	Without any option, this command displays a summary of the IS-IS route information
instance	Displays IS-IS route information for an instance
<afi> <safi>	Routing information for the specified AFI/SAFI. Supported SAFI values are 'unicast' and 'labeled-unicast'.

Example 1: Summary view of the IS-IS routes

```
supervisor@rtbrick>spine1: op> show isis route
Instance: default, AFI: ipv4, SAFI: unicast
  Prefix                   Level   Metric     Type         Next Hop       Interface
  16.0.1.0/24                  1   1000000    Internal     n/a            local
  16.0.2.0/24                  1   1000000    Internal     n/a            local
  192.168.1.1/32               1   1000000    Internal     n/a            local
  192.168.1.6/32               1   2000000    Internal     16.0.2.6       ifl-0/0/2/1
                                                           16.0.1.6       ifl-0/0/2/0
Instance: default, AFI: ipv4, SAFI: labeled-unicast
  Prefix                   Level   Metric     SID Index    Next Hop       Interface   Label
  192.168.1.6/32               1   2000000    600          16.0.2.6       ifl-0/0/2/1
                                                           16.0.1.6       ifl-0/0/2/0
Instance: default, AFI: ipv6, SAFI: unicast
  Prefix                   Level   Metric     Type         Next Hop       Interface
  16:0:1::/64                  1   1000000    Internal     n/a            local
  16:0:2::/64                  1   1000000    Internal     n/a            local
  192:168:1::1/128             1   1000000    Internal     n/a            local
  192:168:1::6/128             1   2000000    Internal     fe80::7847:eff:fec0:0     ifl-0/0/2/0

<...>
```

Example 2: Summary view of the IS-IS routes for the specified instance

```
supervisor@rtbrick>spine1: op> show isis route instance default
Instance: default, AFI: ipv4, SAFI: unicast
  Prefix                   Level   Metric     Type         Next Hop            Interface
  16.0.1.0/24                  1   1000000    Internal     n/a                 local
  16.0.2.0/24                  1   1000000    Internal     n/a                 local
  192.168.1.1/32               1   1000000    Internal     n/a                 local
```

```
  192.168.1.6/32               1   2000000    Internal     16.0.2.6            ifl-0/0/2/1
                                                           16.0.1.6            ifl-0/0/2/0

Instance: default, AFI: ipv4, SAFI: labeled-unicast
  Prefix                    Level   Metric     SID Index    Next Hop            Interface   Label
  192.168.1.6/32               1   2000000    600          16.0.2.6            ifl-0/0/2/1
                                                           16.0.1.6            ifl-0/0/2/0

Instance: default, AFI: ipv6, SAFI: unicast
  Prefix                    Level   Metric     Type         Next Hop             Interface
  16:0:1::/64                  1   1000000    Internal     n/a                  local
  16:0:2::/64                  1   1000000    Internal     n/a                  local
  192:168:1::1/128             1   1000000    Internal     n/a                  local
  192:168:1::6/128             1   2000000    Internal     fe80::7847:eff:fec0:0 ifl-0/0/2/0
                                                           fe80::7847:e00:1c0:0  ifl-0/0/2/1

<...>
```

Example 3: Summary view of the IS-IS routes for the specified instance and address family (IPv4 unicast).

```
supervisor@rtbrick>spine1: op> show isis route instance default ipv4 unicast
Instance: default, AFI: ipv4, SAFI: unicast
  Prefix             Level   Metric     Type         Next Hop   Interface
  16.0.1.0/24            1   1000000    Internal     n/a        local
  16.0.2.0/24            1   1000000    Internal     n/a        local
  192.168.1.1/32         1   1000000    Internal     n/a        local
  192.168.1.6/32             2000000    Internal     16.0.2.6   ifl-0/0/2/1
                                                     16.0.1.6   ifl-0/0/2/0
```

Example 4: Summary view of the IS-IS routes for the specified instance and address family (IPv4 labeled-unicast).

```
supervisor@rtbrick>spine1: op> show isis route instance default ipv4 labeled-unicast
Instance: default, AFI: ipv4, SAFI: labeled-unicast
  Prefix        Level   Metric     SID Index    Next Hop        Interface   Label
  192.168.1.6/32    1   2000000    600          16.0.2.6        ifl-0/0/2/1
                                                16.0.1.6        ifl-0/0/2/0
```

Example 5: Summary view of the IS-IS routes for the specified instance and address family (IPv6 unicast).

```
supervisor@rtbrick>spine1: op> show isis route instance default ipv6 unicast
Instance: default, AFI: ipv6, SAFI: unicast
  Prefix             Level   Metric     Type         Next Hop
Interface
  16:0:1::/64            1   1000000    Internal     n/a                       local
  16:0:2::/64            1   1000000    Internal     n/a                       local
  192:168:1::1/128       1   1000000    Internal     n/a                       local
  192:168:1::6/128       1   2000000    Internal     fe80::7847:eff:fec0:0   ifl-
0/0/2/0
                                                     fe80::7847:e00:1c0:0    ifl-
0/0/2/1
```

IS-IS Segment Routing

Syntax:

show isis segment-routing <option>

Option	Description
global-block	Displays Segment routing global block (SRGB) information
global-block instance <instance>	Displays Segment routing global block (SRGB) information for the specified instance
label-binding	Displays the IS-IS segment routing label bindings information
label-binding instance <instance>	Displays the IS-IS segment routing label bindings for the specified instance
prefix-segment	Displays the IS-IS prefix segments information
prefix-segment <instance>	Displays the IS-IS prefix segments for the specified instance
adjacency-segment	Displays the neighbor information for each SID, which helps users identify to which adjacency the SID belongs.

Example 1: Summary view of the IS-IS segment routing global block

```
supervisor@rtbrick>spine1: op> show isis segment-routing global-block
Instance: default, Level: 1
  System                    SRGB Base   SRGB Range
  isr1                           1000         1000
  isr6                           6000         1000
Instance: default, Level: 2
  System                    SRGB Base   SRGB Range
  isr1                           1000         1000
  isr6                           6000         1000
```

Example 2: Summary view of the IS-IS segment routing label binding

```
supervisor@rtbrick>spine1: op> show isis segment-routing label-binding
Instance: default, Level: 1
  System        Prefix                  Range   SID     Flags
Instance: default, Level: 2
```

```
  System        refix                  Range   SID     Flags
```

Example 3: Summary view of the IS-IS segment routing prefix segment

```
supervisor@rtbrick>spine1: op> show isis segment-routing prefix-segment
Instance: default, Level: 1
  System                    Prefix                    SID     Flags
  isr1                      192.168.1.1/32              100   Node
  isr1                      192:168:1::1/128            102   Node
  isr6                      192.168.1.6/32              600   Node
  isr6                      192:168:1::6/128            601   Node
Instance: default, Level: 2
  System                    Prefix                     SID     Flags
  isr1                      192.168.1.1/32               100   Node
  isr1                      192.168.1.6/32               600   Re-advertisement,
Node
  isr1                      192:168:1::1/128             102   Node
  isr1                      192:168:1::6/128             601   Re-advertisement,
Node
  isr6                      192.168.1.1/32               100   Re-advertisement,
Node
  isr6                      192.168.1.6/32               600   Node
  isr6                      192:168:1::1/128             102   Re-advertisement,
Node
  isr6                      192:168:1::6/128             601   Node
```

Example 4: Summary view of the IS-IS segment routing adjacency-segment

```
supervisor@rtbrick>switch: op> show isis segment-routing adjacency-segment
Instance: default, Level: 1
  Local System ID   Remote System ID    Label     Interface       Flags
  isr1              isr2                20112     ifl-0/0/0/0     Value, Local,
Persistent
  isr1              isr2                20312     ifl-0/0/0/0     Ipv6
Encapsulation, Value, Local, Persistent
  isr2              isr1                21121     -               Value, Local,
Persistent
  isr2              isr1                21321     -               Ipv6
Encapsulation, Value, Local, Persistent
Instance: default, Level: 2
  Local System ID   Remote System ID    Label     Interface       Flags
  isr1              isr2                20112     ifl-0/0/0/0     Value, Local,
Persistent
  isr1              isr2                20312     ifl -0/0/0/0    Ipv6
Encapsulation, Value, Local, Persistent
  isr2              isr1                21121     -               Value, Local,
Persistent
  isr2              isr1                21321     -               Ipv6
Encapsulation, Value, Local, Persistent
<….>
```

IS-IS SPF

Syntax:

show isis spf <option>

Option	Description
result	Displays a summary of the IS-IS SPF results
result <instance>	Displays a summary of the IS-IS SPF results for the specified instance
result [level-1/level2]	Displays a summary of the IS-IS SPF results for the specified level.

Example 1: Summary view of the IS-IS SPF result

```
supervisor@rtbrick>spine1: op> show isis spf result
Instance: default, Level: 1
  Destination Node          Metric     Neighbor Node         Interface       Nexthop   Address
  1921.6800.1001.00                0                         local
  1921.6800.1006.00          1000000   1921.6800.1006.00     ifl-0/0/2/0     IPv6      fe80::7847:eff:fec0:0
                                       1921.6800.1006.00     ifl-0/0/2/1     IPv6      fe80::7847:e00:1c0:0
                                       1921.6800.1006.00     ifl-0/0/2/0     IPv4      16.0.1.6
                                       1921.6800.1006.00     ifl-0/0/2/1     IPv4      16.0.2.6
  1921.6800.1006.01          1000000                           local
Instance: default, Level: 2
  Destination Node          Metric     Neighbor Node         Interface         Nexthop   Address
  1921.6800.1001.00                0                           local
  1921.6800.1006.00          1000000   1921.6800.1006.00     ifl-0/0/2/0      IPv6      fe80::7847:eff:fec0:0
                                       1921.6800.1006.00     ifl-0/0/2/1      IPv6      fe80::7847:e00:1c0:0
                                       1921.6800.1006.00     ifl-0/0/2/0      IPv4      16.0.1.6
                                       1921.6800.1006.00     ifl-0/0/2/1      IPv4      16.0.2.6
  1921.6800.1006.01          1000000                           local
```

Example 2: Summary view of the IS-IS SPF result for level-1

```
supervisor@rtbrick>spine1: op> show isis spf result level-1
Instance: default, Level: 1
  Destination Node          Metric       Neighbor Node         Interface         Nexthop   Address
  1921.6800.1001.00                0                           local
  1921.6800.1006.00          1000000     1921.6800.1006.00     ifl-0/0/2/0    IPv6      fe80::7847:eff:fec0:0
                                         1921.6800.1006.00     ifl-0/0/2/1    IPv6      fe80::7847:e00:1c0:0
                                         1921.6800.1006.00     ifl-0/0/2/0    IPv4      16.0.1.6
                                         1921.6800.1006.00     ifl-0/0/2/1    IPv4      16.0.2.6
  1921.6800.1006.01          1000000                           local
```

Example 3: Summary view of the IS-IS SPF result for level-2

```
supervisor@rtbrick>spine1: op> show isis spf result level-2
Instance: default, Level: 2
  Destination Node          Metric       Neighbor Node         Interface         Nexthop   Address
```

```
  1921.6800.1001.00               0                       local
  1921.6800.1006.00         1000000     1921.6800.1006.00     ifl-0/0/2/0       IPv6
fe80::7847:eff:fec0:0
                                        1921.6800.1006.00     ifl-0/0/2/1       IPv6
fe80::7847:e00:1c0:0
                                        1921.6800.1006.00     ifl-0/0/2/0       IPv4      16.0.1.6
                                        1921.6800.1006.00     ifl-0/0/2/1    IPv4      16.0.2.6
  1921.6800.1006.01         1000000                           local
```

Example 4: Summary view of the IS-IS SPF result of a specific instance for level-1

```
supervisor@rtbrick>spine1: op> show isis spf result instance default level-1
Instance: default, Level: 1
  Destination Node          Metric       Neighbor Node         Interface         Nexthop   Address
  1921.6800.1001.00               0                           local
  1921.6800.1006.00         1000000     1921.6800.1006.00     ifl-0/0/2/0       IPv6
fe80::7847:eff:fec0:0
                                        1921.6800.1006.00     ifl-0/0/2/1       IPv6
fe80::7847:e00:1c0:0
                                        1921.6800.1006.00     ifl-0/0/2/0       IPv4      16.0.1.6
                                        1921.6800.1006.00     ifl-0/0/2/1       IPv4      16.0.2.6
  1921.6800.1006.01         1000000                           local
```

Example 5: Summary view of the IS-IS SPF result of a specific instance for level-2

```
supervisor@rtbrick>spine1: op> show isis spf result instance default level-2
Instance: default, Level: 2
  Destination Node          Metric       Neighbor Node         Interface         Nexthop   Address
  1921.6800.1001.00               0                           local
  1921.6800.1006.00         1000000     1921.6800.1006.00     ifl-0/0/2/0       IPv6
fe80::7847:eff:fec0:0
                                        1921.6800.1006.00     ifl-0/0/2/1       IPv6
fe80::7847:e00:1c0:0
                                        1921.6800.1006.00     ifl-0/0/2/0       IPv4      16.0.1.6
                                        1921.6800.1006.00     ifl-0/0/2/1       IPv4      16.0.2.6
  1921.6800.1006.01         1000000                           local
```

IS-IS Clear Commands

Clear commands allow to reset operational states.

IS-IS Interface

Syntax:

clear isis interface <option> ...

Option	Description
statistics	Clears the statistics of all IS-IS interfaces.

Example: The example below shows how to clear IS-IS interface statistics.

```
supervisor@rtbrick>spine1: op> clear isis interface statistics
```

IS-IS Neighbor

Syntax:

clear isis neighbor <option> ...

Option	Description
neighbor	Clears neighbors of the default instance
neighbor instance <instance_name>	Clears neighbors of the specified instance
neighbor instance <instance_name> interface <interface-name>	Clears the specified interface of a specified neighbor instance

Example: The example below shows how to clear neighbors of the specified instance

```
supervisor@rtbrick>spine1: op> clear isis neighbor instance default
```



To access the Operational State API that corresponds to this CLI, click include::common:partial$operational_api_links.adoc[tag=clear_isis_neighbor].

IS-IS Database

Syntax:

clear isis database <option> ...

Option	Description
Instance	Clears neighbors of the default instance
level-1	Clears area level-1

Option	Description
level-2	Clears area level-2
lsp	Clears IS-IS database for the specific LSP ID
System	Clears the LSDB system ID

Example: The example below shows how to clear the database instance

```
supervisor@rtbrick>spine1: op> clear isis database instance default
```

The LSDB data is cleared for instance default

IS-IS Level 2 to Level 1 Route Leak

The command displays the IS-IS Route Leak information.

show isis database level-1 system <name>

Option	Description
name	Name of system.

Example: The output shows the Level-1 ISIS LSP for isr2 is active and advertises both IPv4 and IPv6 reachability along with segment routing (SRGB base 2000, range 1000). The LSP is attached, authenticated with MD5. Most of the prefixes are 'Up' and a few are marked 'Down'.

```
supervisor@rtbrick.net: cfg> show isis database level-1 system isr2
Instance: default, Level: 1
  LSP ID: isr2.00-00
    Interface:
    LSP Header:
      Sequence: 0xb
      Checksum: 0xe00a
      Remaining lifetime: 65535 seconds
      Flags: Attached: 1, Overload: 0
    Packet:
      Length: 403 bytes
      Last received time: 2025-10-31T09:33:37.286075+0000
      Expiry: expires in 18h 12m 6s 300902us
    System ID: 1921.6800.1002
    Dynamic Hostname TLV (137): isr2
    Protocols Supported TLVs (129):
      Network layer protocol ID: IPv6
      Network layer protocol ID: IPv4
```

```
    Area Address TLVs (1):
      Area address: 49.0001
    Authentication TLV (10):
      Type: md5
      Value: 6ae3e3148e689a4e2654b20b2a287956
    IS Reachability TLVs (22):
      IS neighbor: 1921.6800.1001.00              Metric:  1000000
      IS neighbor: 1921.6800.1001.00              Metric:  1000000
      IS neighbor: 1921.6800.1002.02              Metric:  1000000
    IPv4 Reachability TLVs (135):
      IPv4 prefix: 12.0.1.0/24                    Metric:  1000000   Internal   Up
      IPv4 prefix: 12.0.2.0/24                    Metric:  1000000   Internal   Up
      IPv4 prefix: 12.1.1.0/24                    Metric:  1000000   Internal   Up
      IPv4 prefix: 23.0.1.0/24                    Metric:  1000000   Internal   Up
      IPv4 prefix: 23.0.2.0/24                    Metric:  1000000   Internal   Up
      IPv4 prefix: 182.168.1.2/32                 Metric:  1000000   Internal   Up
      IPv4 prefix: 182.168.1.3/32                 Metric:  2000000   Internal
Down
      IPv4 prefix: 192.168.1.2/32                 Metric:  1000000   Internal   Up
SID:  200   Flags: Node
      IPv4 prefix: 192.168.1.3/32                 Metric:  2000000   Internal
Down   SID:  300   Flags: Re-advertisement, Node
    IPv6 Reachability TLVs (236):
      IPv6 prefix: 12:0:1::/64                    Metric:  1000000   Internal   Up
      IPv6 prefix: 12:0:2::/64                    Metric:  1000000   Internal   Up
      IPv6 prefix: 12:1:1::/64                    Metric:  1000000   Internal   Up
      IPv6 prefix: 23:0:1::/64                    Metric:  1000000   Internal   Up
      IPv6 prefix: 23:0:2::/64                    Metric:  1000000   Internal   Up
      IPv6 prefix: 182:168:1::2/128               Metric:  1000000   Internal   Up
      IPv6 prefix: 182:168:1::3/128               Metric:  2000000   Internal
Down
      IPv6 prefix: 192:168:1::2/128               Metric:  1000000   Internal   Up
SID:  201   Flags: Node
      IPv6 prefix: 192:168:1::3/128               Metric:  2000000   Internal
Down   SID:  301   Flags: Re-advertisement, Node
    Segment Routing TLVs (242/sub 2):
      SRGB: Base: 2000, Range: 1000, Router ID: 182.168.1.2
```

Example output for policy configuration that allows only a specific IPv4 route to be leaked from level2 to level1 and blocking the other level 2 route leaking to level 1.

```
supervisor@rtbrick.net: cfg> show isis database level-1 system isr2
Instance: default, Level: 1
  LSP ID: isr2.00-00
    Interface:
    LSP Header:
      Sequence: 0x8
      Checksum: 0x3d0e
      Remaining lifetime: 65535 seconds
      Flags: Attached: 1, Overload: 0
    Packet:
      Length: 330 bytes
      Last received time: 2025-10-31T09:17:18.776717+0000
      Expiry: expires in 18h 47s 654403us
    System ID: 1921.6800.1002
    Dynamic Hostname TLV (137): isr2
    Protocols Supported TLVs (129):
      Network layer protocol ID: IPv6
```

```
      Network layer protocol ID: IPv4
    Area Address TLVs (1):
      Area address: 49.0001
    Authentication TLV (10):
      Type: md5
      Value: 7b73528a23fd72fb77345c460378fa0d
    IS Reachability TLVs (22):
      IS neighbor: 1921.6800.1001.00              Metric:  1000000
      IS neighbor: 1921.6800.1001.00              Metric:  1000000
      IS neighbor: 1921.6800.1002.02              Metric:  1000000
    IPv4 Reachability TLVs (135):
      IPv4 prefix: 12.0.1.0/24                    Metric:  1000000   Internal   Up
      IPv4 prefix: 12.0.2.0/24                    Metric:  1000000   Internal   Up
      IPv4 prefix: 12.1.1.0/24                    Metric:  1000000   Internal   Up
      IPv4 prefix: 23.0.1.0/24                    Metric:  1000000   Internal   Up
      IPv4 prefix: 23.0.2.0/24                    Metric:  1000000   Internal   Up
      IPv4 prefix: 182.168.1.2/32                 Metric:  1000000   Internal   Up
      IPv4 prefix: 192.168.1.2/32                 Metric:  1000000   Internal   Up
SID:  200   Flags: Node
      IPv4 prefix: 192.168.1.3/32                 Metric:  2000000   Internal
Down   SID:  300   Flags: Re-advertisement, Node
    IPv6 Reachability TLVs (236):
      IPv6 prefix: 12:0:1::/64                    Metric:  1000000   Internal   Up
      IPv6 prefix: 12:0:2::/64                    Metric:  1000000   Internal   Up
      IPv6 prefix: 12:1:1::/64                    Metric:  1000000   Internal   Up
      IPv6 prefix: 23:0:1::/64                    Metric:  1000000   Internal   Up
      IPv6 prefix: 23:0:2::/64                    Metric:  1000000   Internal   Up
      IPv6 prefix: 182:168:1::2/128               Metric:  1000000   Internal   Up
      IPv6 prefix: 192:168:1::2/128               Metric:  1000000   Internal   Up
SID:  201   Flags: Node
    Segment Routing TLVs (242/sub 2):
      SRGB: Base: 2000, Range: 1000, Router ID: 182.168.1.2
```

2.7. OSPFv2/v3

2.7.1. OSPF Overview

OSPF (Open Shortest Path First) is an Interior Gateway Protocol that distributes routing information within a single Autonomous System (AS) in an IP network. OSPF is a link-state routing protocol that uses link-state information to form a routing table and exchange the routing information with the neighbors.

RtBrick FullStack (RBFS) supports OSPF version 2 (OSPFv2) and OSPF version 3 (OSPFv3), including authentication, LDP-IGP sync, and redistribution policy. RBFS does not support OSPFv3 Virtual Link.

OSPF routers flood LSAs (link-state advertisements) to all other routers in an autonomous system. Routers generate routing tables using the information received from the LSAs and calculate the best path to other routers in the network. OSPF uses the Dijkstra (Shortest Path First) algorithm to calculate the best path.

LSAs contain local state information such as interfaces and the reachability of neighbors. Other routers, which receive this information as LSAs, build their LSDB (link-state database) using this information. In an OSPF network, all routers build and maintain information about the topology of that network.

OSPFv3

OSPF Version 3 (OSPFv3) is a modified version of OSPF and it provides support for the OSPF routing protocol within an IPv6 network. As such, it provides support for IPv6 addresses and prefixes. It retains most of the structure and functions in OSPFv2 (for IPv4) with a few changes.

OSPFv3 differs from OSPFv2 in the following ways:

- OSPFv3 runs on IPv6, which is based on links rather than network segments
- OSPFv3 does not depend on IP addresses
- OSPFv3 packets and the LSA format have the following changes:

  OSPFv3 router LSAs and network LSAs do not contain IP addresses, which are advertised by Type 8 LSAs and Type 9 LSAs
- In OSPFv3, information about the flooding scope is added in the LSA Type field

  OSPFv3 stores or floods unidentified packets, whereas OSPFv2 discards
- OSPFv3 supports multi-process on a link with instance ID
- OSPFv3 uses IPv6 link-local addresses for forwarding

OSPFv3 Instance ID

One of the advancements of OSPFv3 over OSPFv2 is the use of the instance ID. This instance ID is an 8-bit field within the OSPFv3 header.

The original intent for the instance ID was to support multiple instances of OSPFv3 to run on the same interface. In this way, you can manipulate which routers on a particular segment are allowed to form adjacencies. You could use an instance number of 0 through 255 to distinguish between the different OSPFv3 instances.

However, within RFC 5838, the instance ID was re-purposed to be used to support address families (AFs) with OSPFv3. The default instance of 0 is used if no other instance is defined. However, specific ranges of the instance ID map to specific AFs. According to the RFC, these ranges are:

- Instance ID 0 to 31 — IPv6 unicast AF
- Instance ID 32 to 63 — IPv6 multicast AF
- Instance ID 64 to 95 — IPv4 unicast AF
- Instance ID 96 to 127 — IPv4 multicast AF
- Instance ID 128 to 255 — Unassigned

When using IPv4 unicast or IPv6 unicast, the allowed values for the command are between 0 and 31.



RBFS only supports IPv6 unicast addresses ranging from 0 to 31.

Understanding OSPF Areas

OSPF allows for a logical partition of the autonomous system by dividing it into areas. This logical partitioning helps to limit the flooding of link-state updates within an area.

An OSPF Autonomous System can be maintained as a single-area network or can be divided as a multi-area network. In a single area AS, the topology provides link-state information of routers in the entire autonomous system.

In a multi-area AS, the topology provides the link-state information of routers belonging to that particular area, not about routers in other areas in the autonomous system. Within an area, all OSPF routers maintain separate databases which are identical.

In a multi-area OSPF network, all areas are connected to the backbone area, known as Area 0.

Backbone Area

The backbone area, also known as Area 0, is connected to all other areas in an OSPF network. The backbone area, which acts as a central point of communication, receives LSAs from other areas and disseminates the same to other areas.

Area Border Router

Routers that connect one or more areas with the backbone area are called Area Border Router (ABR). One interface of the ABR is connected to the backbone, while other interfaces are connected to other areas. ABRs, which belong to multiple

areas in an OSPF network, maintain separate LSDBs for each area that they are connected to.

The following OSPF architectural diagram shows a simple OSPF network that is divided into areas. Area 1 and Area 2 are connected to the backbone area (Area 0) through the ABRs. Area 1 and Area 2 are not directly connected. They receive link state advertisements from each other from Area 0 which acts as the central point of communication for all other areas.

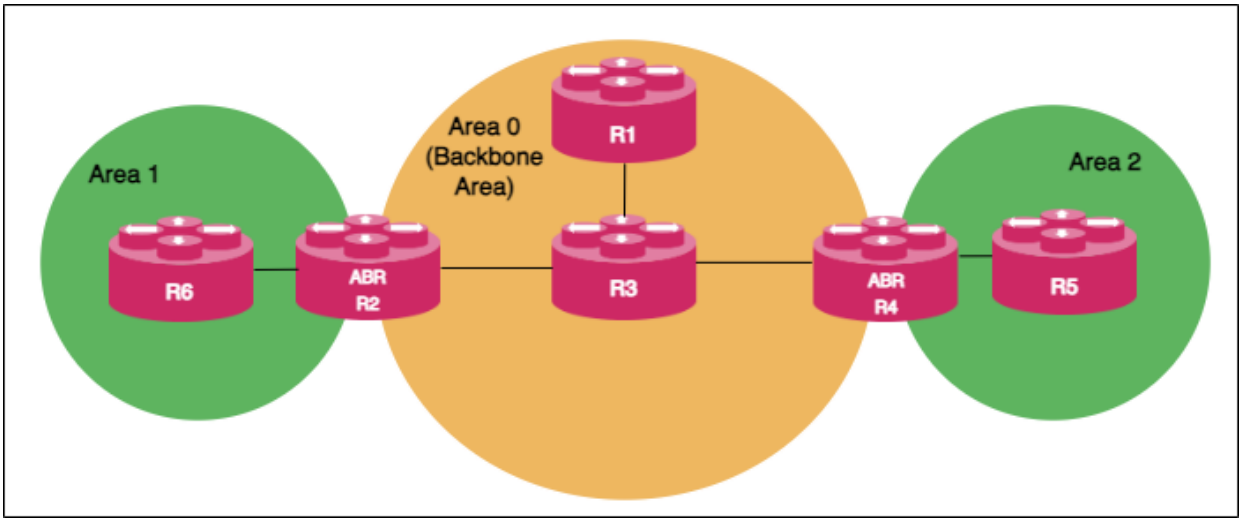


Figure 16. OSPF Areas

Autonomous System Boundary Router

ASBR (Autonomous System Boundary Router) serves as a gateway router to the OSPF autonomous system. ASBR can operate multiple protocols and work with other autonomous system routers that run other interior gateway protocols such as EIGRP, IS-IS, i-BGP, and so on. ASBR can import and translate different protocol routes into OSPF through the redistribution mechanism.

OSPF DR and BDR Election

An OSPF network chooses one router as a Designated Router (DR) and another as a Backup Designated Router (BDR) for a broadcast network.

DR acts as a central point of communication by receiving and distributing topology information. BDR takes over the role of DR if the DR fails. Routers in an OSPF network do not directly exchange routing information with each other. Instead, every router in the network updates routing information only with DR and BDR. DR, in turn, distributes the topology information with all other routers. This mechanism reduces network traffic significantly. OSPF chooses one router as DR

and another router as BDR based on the following criteria:

- The router with the highest priority value becomes the designated router and the router with the second highest priority value becomes the BDR. You can define the priority values for routers during the interface configuration.
- If multiple routers have the same highest priority value, then the router with the highest router ID is elected as DR and the router with the second highest router ID value becomes the BDR.

You can choose a priority value from the range 0 - 255. Routers with the priority value '0' do not participate in the DR or BDR election.

Supported OSPF Standards

RBFS supports the following RFCs, which define standards for OSPFv2 and OSPFv3.

- RFC 2328, OSPF Version 2
- RFC 5340, OSPF for IPv6
- RFC 5709, OSPFv2 HMAC-SHA Cryptographic Authentication
- RFC 7166, Supporting Authentication Trailer for OSPFv3
- RFC 8665, OSPF Extensions for Segment Routing
- RFC 8666, OSPFv3 Extensions for Segment Routing



RFC and draft compliance are partial except as specified.

Supported Platforms

Not all features are necessarily supported on each hardware platform. Refer to the *Platform Guide* for the features and the sub-features that are or are not supported by each platform.

2.7.2. OSPF Configuration

Configuration Hierarchy

The diagram illustrates the OSPF configuration hierarchy. All OSPF configuration is performed within an instance, for example, the default instance or a VPN service instance. The OSPF instance configuration hierarchy includes parameters that are

generic to the respective OSPF instance. The sub-hierarchies include parameters that are specific to redistribution or authentication.

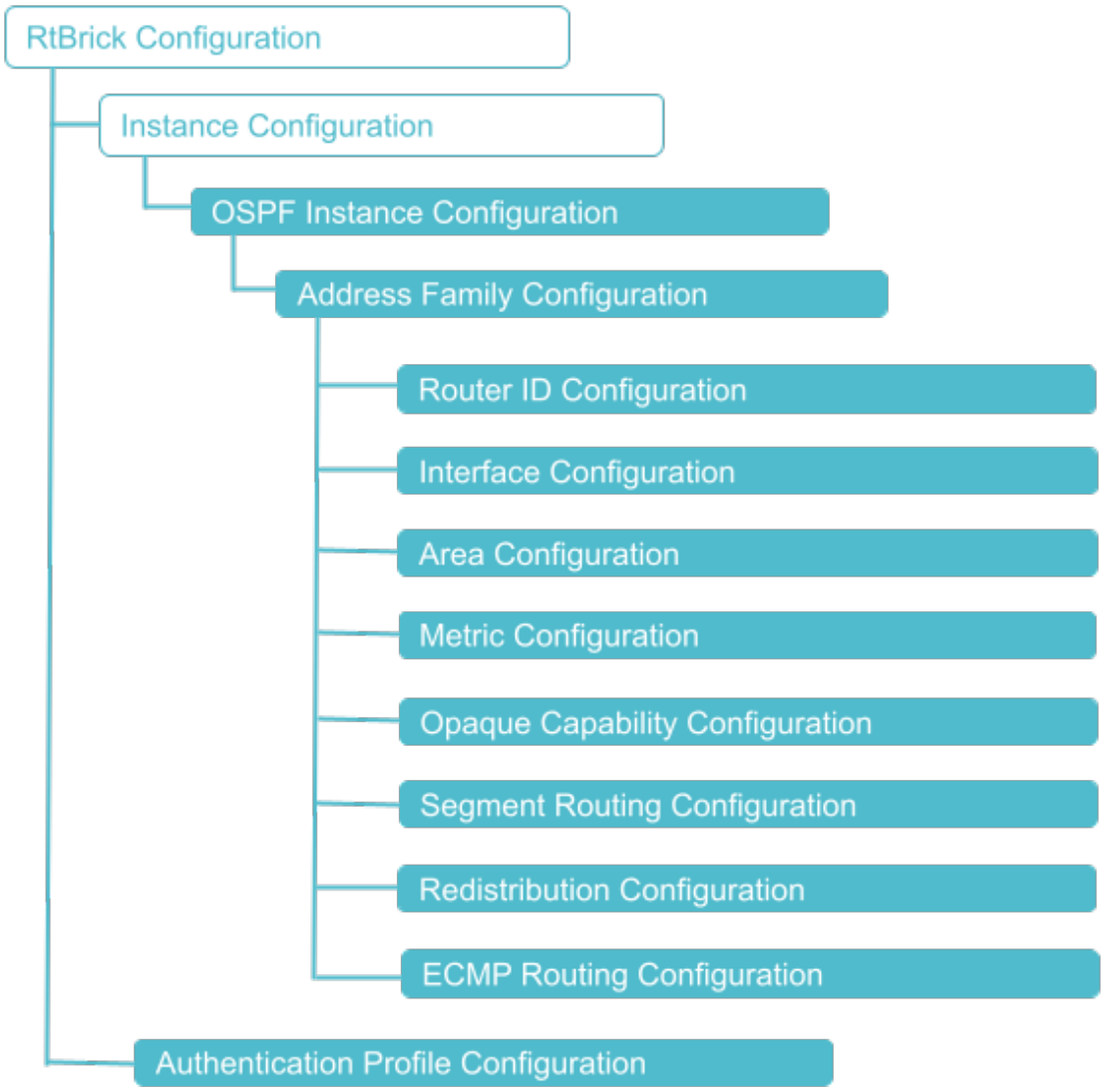


Figure 17. OSPF Configuration Hierarchy

Configuration Syntax and Commands

The following sections describe the OSPF configuration syntax and commands.

OSPF Instance Configuration

At this configuration hierarchy, you can configure an OSPF instance.

Syntax:

```
set instance <instance-name> protocol ospf
```

Attribute	Description
<instance-name>	Name of the OSPF instance.

To access the RESTCONF API that corresponds to this CLI, click here.

OSPF Address Family Configuration

At this configuration level, you configure the OSPF protocol address family.

You must configure the OSPF address family on an OSPF instance before configuring other supported OSPF features.

Syntax

set instance <instance-name> **protocol ospf address-family** <afi>

Attribute	Description
<instance-name>	Name of the instance
<afi>	Specifies the Address family identifier (AFI), either IPv4 or IPv6.

The following example shows the OSPF address family (IPv4) configuration.

Example: OSPF Instance Address Family IPv4 Configuration

This configuration sets up the IPv4 address family for the OSPF protocol. It defines router ID, OSPF area (0.0.0.0), and the interfaces (ifl-0/0/0/1 and lo-0/0/0/1) associated with that area and specifies a point-to-point network type for ifl-0/0/0/1.

```
set instance default protocol ospf address-family ipv4
set instance default protocol ospf address-family ipv4 router-id 198.51.100.10
set instance default protocol ospf address-family ipv4 area 0.0.0.0
set instance default protocol ospf address-family ipv4 area 0.0.0.0 interface ifl-
0/0/0/1
set instance default protocol ospf address-family ipv4 area 0.0.0.0 interface ifl-
0/0/0/1 network-type p2p
set instance default protocol ospf address-family ipv4 area 0.0.0.0 interface lo-
0/0/0/1
```

```
supervisor@rtbrick>SPINE01: cfg> show config instance default protocol ospf address-family ipv4
{
```

```
  "rtbrick-config:ipv4": {
    "router-id": "198.51.100.10",
    "area": [
      {
        "area-id": "0.0.0.0",
        "interface": [
          {
            "name": "ifl-0/0/0/1",
            "network-type": "p2p"
          },
          {
            "name": "lo-0/0/0/1"
          }
        ]
      }
    ]
  }
}
<...>
```

Example: OSPF Instance Address Family IPv6 Configuration

The following example shows the OSPF IPv6 address family configuration. This configuration sets up an OSPF instance for the IPv6 address family. It defines a router ID, a default metric, and enables segment routing with a specified SRGB. It also configures route redistribution from BGP and direct routes using the policy named 'ospf_policy_1'. It also configures an OSPF area '0.0.0.0' and lists a few interfaces (ifl-0/0/0/1 , ifl-0/0/0/100, ifl-0/0/1/1, and ifl-0/0/1/100) within this area, each with a specific metric, network type (where applicable), and an authentication profile named 'AUTH_PROFILE_SHA_512_1'.

```
set instance default protocol ospf address-family ipv6 instance-id 0 router-id
192.168.0.10
set instance default protocol ospf address-family ipv6 instance-id 0 metric 1000
set instance default protocol ospf address-family ipv6 instance-id 0 segment-
routing status enable
set instance default protocol ospf address-family ipv6 instance-id 0 segment-
routing srgb base 1000
set instance default protocol ospf address-family ipv6 instance-id 0 segment-
routing srgb range 1000
set instance default protocol ospf address-family ipv6 instance-id 0 redistribute
source bgp metric 2000
set instance default protocol ospf address-family ipv6 instance-id 0 redistribute
source direct policy ospf_policy_1
set instance default protocol ospf address-family ipv6 instance-id 0 area 0.0.0.0
metric 1000
set instance default protocol ospf address-family ipv6 instance-id 0 area 0.0.0.0
interface ifl-0/0/0/1 authentication-profile AUTH_PROFILE_SHA_512_1
set instance default protocol ospf address-family ipv6 instance-id 0 area 0.0.0.0
interface ifl-0/0/0/100 metric 20000
set instance default protocol ospf address-family ipv6 instance-id 0 area 0.0.0.0
interface ifl-0/0/0/100 network-type p2p
set instance default protocol ospf address-family ipv6 instance-id 0 area 0.0.0.0
interface ifl-0/0/0/100 authentication-profile AUTH_PROFILE_SHA_512_1
set instance default protocol ospf address-family ipv6 instance-id 0 area 0.0.0.0
interface ifl-0/0/1/1 metric 40000
```

```
set instance default protocol ospf address-family ipv6 instance-id 0 area 0.0.0.0
interface ifl-0/0/1/1 network-type p2p
set instance default protocol ospf address-family ipv6 instance-id 0 area 0.0.0.0
interface ifl-0/0/1/1 authentication-profile AUTH_PROFILE_SHA_512_1
set instance default protocol ospf address-family ipv6 instance-id 0 area 0.0.0.0
interface ifl-0/0/1/100 metric 30000
set instance default protocol ospf address-family ipv6 instance-id 0 area 0.0.0.0
interface ifl-0/0/1/100 authentication-profile AUTH_PROFILE_SHA_512_1
```

```
supervisor@rtbrick>SPINE01: cfg> show config instance default protocol ospf address-family ipv6
{
  "rtbrick-config:ipv6": {
    "instance-id": [
      {
        "instance-id": 0,
        "router-id": "192.168.0.10",
        "metric": 1000,
        "segment-routing": {
          "status": "enable",
          "srgb": {
            "base": 1000,
            "range": 1000
          }
        },
        "redistribute": [
          {
            "source": "bgp",
            "metric": 2000
          },
          {
            "source": "direct",
            "policy": "ospf_policy_1"
          }
        ],
        "area": [
          {
            "area-id": "0.0.0.0",
            "metric": 1000,
            "interface": [
              {
                "name": "ifl-0/0/0/1",
                "authentication-profile": "AUTH_PROFILE_SHA_512_1"
              },
              {
                "name": "ifl-0/0/0/100",
                "metric": 20000,
                "network-type": "p2p",
                "authentication-profile": "AUTH_PROFILE_SHA_512_1"
              },
              {
                "name": "ifl-0/0/1/1",
                "metric": 40000,
                "network-type": "p2p",
                "authentication-profile": "AUTH_PROFILE_SHA_512_1"
              },
              {
                "name": "ifl-0/0/1/100",
                "metric": 30000,
                "authentication-profile": "AUTH_PROFILE_SHA_512_1"
<...>
```

To access the RESTCONF API that corresponds to this CLI, click here.

OSPF Router ID Configuration

The router ID is an IP address that OSPF uses to identify a device on the network. The router ID should be configured under the address family hierarchy.

Syntax

set instance <instance-name> **protocol ospf address-family** <afi> <attribute> <value>

Attribute	Description
<afi>	Specifies the Address family identifier (AFI), either IPv4 or IPv6.
<afi> instance-id <instance-id>	Specifies the instance ID. When using an IPv6 address family with OSPFv3, an instance ID ranging from 0 to 31 must be specified.
router-id <ipv4-address>	The router ID of the routing instance. It is recommended to specify the router ID.

Example: OSPF IPv4 Router Identifier Configuration

This command configures router ID for a router that belong to the OSPF IPv4 address family.

```
set instance default protocol ospf address-family ipv4 router-id 192.168.0.10
```

```
supervisor@rtbrick: cfg> show config instance default protocol ospf address-family
ipv4 router-id
{
  "rtbrick-config:router-id": "192.168.0.10"
}
```

Example: OSPF IPv6 Router Identifier Configuration

This command configures router ID for OSPF the IPv6 address family. It sets the router's unique identifier (192.168.0.10) for the OSPF instance 0.

```
set instance default protocol ospf address-family ipv6 instance-id 0 router-id
192.168.0.10
```

```
supervisor@rtbrick: cfg> show config instance default protocol ospf address-family
ipv6 instance-id 0 router-id
{
  "rtbrick-config:router-id": "192.168.0.10"
}
```

OSPF Hostname Configuration

Identifying routers through Open Shortest Path First (OSPF) hostnames can simplify network management as they are easier to remember than router IDs.

Syntax

set instance <instance-name> **protocol ospf address-family** <afi> <attribute> <value>

Attribute	Description
<afi>	Specifies the Address family identifier (AFI), either IPv4 or IPv6.
<afi> instance-id <instance-id>	Specifies the instance ID. When using an IPv6 address family with OSPFv3, an instance ID ranging from 0 to 31 must be specified.
hostname <hostname>	The hostname of the routing instance.

Example: OSPF IPv4 host name Configuration

This command sets the OSPF IPv4 default instance host name to 'multiservice-edge'.

```
set instance default protocol ospf address-family ipv4 hostname multiservice-edge
```

```
supervisor@rtbrick: cfg> show config instance default protocol ospf address-family
ipv4 hostname
{
  "rtbrick-config:hostname": "multiservice-edge"
}
```

Example: OSPF IPv6 host name configuration

This command sets the OSPF IPv6 default instance host name to 'multiservice-edge'.

```
set instance default protocol ospf address-family ipv6 hostname multiservice-edge
```

```
supervisor@rtbrick: cfg> show config instance default protocol ospf address-family
ipv6 instance-id 0 hostname
{
  "rtbrick-config:hostname": "multiservice-edge"
}
```

OSPF Area Configuration

A particular area is defined by its area ID.

set instance <instance-name> **protocol ospf address-family** <afi> <attribute> <value>

Attribute	Description
<afi>	Specifies the Address family identifier (AFI), either IPv4 or IPv6.
<afi> instance-id <instance-id>	Specifies the instance ID. When using an IPv6 address family with OSPFv3, an instance ID ranging from 0 to 31 must be specified.
area <area-id>	Specifies the OSPF area ID.
area <area-id> metric	Area scope metric. Range: 0 - 65535. Default: 10000.
area <area-id> area-type stub	A stub area is an area through which or into which AS external advertisements are not flooded instead type-3 LSA advertise with a default route.
area <area-id> area-type totally-stub	Totally stub area is an area in which type-3 LSAs are not allowed instead type-3 LSAs advertise with a default route.
area <area-id> authentication-profile <authentication-profile>	Specifies the authentication profile name used to create an attachment point at the area level.

Attribute	Description
area <area-id> no-authentication-check <enable>	When enabled, OSPF packets received here will not undergo authentication validation, even if the user has enabled authentication. However, OSPF will continue to send authenticated packets from this interface.

Example: OSPF IPv4 Area Configuration

The following configuration defines OSPFv2 settings for IPv4 under the default instance and associates multiple interfaces with area 0.0.0.0. Each interface is configured with parameters such as metric, network type, and authentication profile. This configuration includes multiple physical and logical interfaces connected to OSPF area 0.0.0.0, with varying interface metrics to manage path preference effectively. For the interface 'ifl-0/0/0/100', the metric is set to 20,000; for 'ifl-0/0/1/1', the metric is set to 40,000; and for 'ifl-0/0/4/1', the metric is set to 60,000. This defines the interface cost, which influences OSPF route selection, the lower the metric, the more preferred the path.

The network type is configured as point-to-point (p2p), indicating that OSPF considers this link as a direct connection between two routers. This point-to-point network type is applied to both the interfaces 'ifl-0/0/1/100' and 'ifl-0/0/1/1'. Also, the loopback interfaces 'lo-0/0/0/1' and 'lo-0/0/0/2' are included in OSPF area '0.0.0.0'.

```
set instance default protocol ospf address-family ipv4 area 0.0.0.0 interface ifl-
0/0/0/1 authentication-profile AUTH_PROFILE_SHA_512_1
set instance default protocol ospf address-family ipv4 area 0.0.0.0 interface ifl-
0/0/0/100 metric 20000
set instance default protocol ospf address-family ipv4 area 0.0.0.0 interface ifl-
0/0/0/100 network-type p2p
set instance default protocol ospf address-family ipv4 area 0.0.0.0 interface ifl-
0/0/0/100 authentication-profile AUTH_PROFILE_SHA_512_1
set instance default protocol ospf address-family ipv4 area 0.0.0.0 interface ifl-
0/0/1/1 metric 40000
set instance default protocol ospf address-family ipv4 area 0.0.0.0 interface ifl-
0/0/1/1 network-type p2p
set instance default protocol ospf address-family ipv4 area 0.0.0.0 interface ifl-
0/0/1/1 authentication-profile AUTH_PROFILE_SHA_512_1
set instance default protocol ospf address-family ipv4 area 0.0.0.0 interface ifl-
0/0/1/100 metric 30000
set instance default protocol ospf address-family ipv4 area 0.0.0.0 interface ifl-
0/0/1/100 authentication-profile AUTH_PROFILE_SHA_512_1
set instance default protocol ospf address-family ipv4 area 0.0.0.0 interface ifl-
0/0/4/1 metric 60000
set instance default protocol ospf address-family ipv4 area 0.0.0.0 interface lo-
0/0/0/1
```

```
set instance default protocol ospf address-family ipv4 area 0.0.0.0 interface lo-
0/0/0/2
```

```
supervisor@rtbrick: cfg> show config instance default protocol ospf address-family ipv4 area 0.0.0.0
{
  "rtbrick-config:area": [
    {
      "area-id": "0.0.0.0",
      "interface": [
        {
          "name": "ifl-0/0/0/1",
          "authentication-profile": "AUTH_PROFILE_SHA_512_1"
        },
        {
          "name": "ifl-0/0/0/100",
          "metric": 20000,
          "network-type": "p2p",
          "authentication-profile": "AUTH_PROFILE_SHA_512_1"
        },
        {
          "name": "ifl-0/0/1/1",
          "metric": 40000,
          "network-type": "p2p",
          "authentication-profile": "AUTH_PROFILE_SHA_512_1"
        },
        {
          "name": "ifl-0/0/1/100",
          "metric": 30000,
          "authentication-profile": "AUTH_PROFILE_SHA_512_1"
        },
        {
          "name": "ifl-0/0/4/1",
          "metric": 60000
        },
        {
          "name": "lo-0/0/0/1"
        },
        {
          "name": "lo-0/0/0/2"
        }
      ]
    }
  ]
}
```

Example: OSPF IPv6 Area Configuration

This configuration defines OSPFv3 (IPv6) settings under the default instance for area 0.0.0.0. Multiple interfaces are associated with this area, each configured with parameters such as metric, network type, and authentication profile. The area includes interfaces under the instance 'default' and instance-id 0. Each interface is configured with parameters such as metric, network type, and authentication profile. It uses the authentication profile 'AUTH_PROFILE_SHA_512_1' for secure OSPF authentication for interfaces 'ifl-0/0/0/1', 'ifl-0/0/0/100', 'ifl-0/0/1/1', and 'ifl-0/0/1/100'.

It configures OSPF settings for this instance, including specific parameters such as metrics, network types, and authentication requirements for the interfaces.

Interfaces 'ifl-0/0/0/100' and 'ifl-0/0/1/1' are configured as point-to-point links. These interfaces also have custom OSPF metrics set to influence route selection: 20,000 and 40,000 respectively. The interface 'ifl-0/0/1/100' uses the same authentication profile and has a metric of 30,000. The interface 'ifl-0/0/4/1' is configured with a metric of 60,000 but does not employ authentication. The loopback interfaces 'lo-0/0/0/1' and 'lo-0/0/0/2' are included in the OSPF configuration.

```
set instance default protocol ospf address-family ipv6 instance-id 0 area 0.0.0.0
interface ifl-0/0/0/1 authentication-profile AUTH_PROFILE_SHA_512_1
set instance default protocol ospf address-family ipv6 instance-id 0 area 0.0.0.0
interface ifl-0/0/0/100 metric 20000
set instance default protocol ospf address-family ipv6 instance-id 0 area 0.0.0.0
interface ifl-0/0/0/100 network-type p2p
set instance default protocol ospf address-family ipv6 instance-id 0 area 0.0.0.0
interface ifl-0/0/0/100 authentication-profile AUTH_PROFILE_SHA_512_1
set instance default protocol ospf address-family ipv6 instance-id 0 area 0.0.0.0
interface ifl-0/0/1/1 metric 40000
set instance default protocol ospf address-family ipv6 instance-id 0 area 0.0.0.0
interface ifl-0/0/1/1 network-type p2p
set instance default protocol ospf address-family ipv6 instance-id 0 area 0.0.0.0
interface ifl-0/0/1/1 authentication-profile AUTH_PROFILE_SHA_512_1
set instance default protocol ospf address-family ipv6 instance-id 0 area 0.0.0.0
interface ifl-0/0/1/100 metric 30000
set instance default protocol ospf address-family ipv6 instance-id 0 area 0.0.0.0
interface ifl-0/0/1/100 authentication-profile AUTH_PROFILE_SHA_512_1
set instance default protocol ospf address-family ipv6 instance-id 0 area 0.0.0.0
interface ifl-0/0/4/1 metric 60000
set instance default protocol ospf address-family ipv6 instance-id 0 area 0.0.0.0
interface lo-0/0/0/1
set instance default protocol ospf address-family ipv6 instance-id 0 area 0.0.0.0
interface lo-0/0/0/2
```

```
supervisor@rtbrick>SPINE01: cfg> show config instance default protocol ospf address-family ipv6 instance-id 0
area 0.0.0.0
{
  "rtbrick-config:area": [
    {
      "area-id": "0.0.0.0",
      "interface": [
        {
          "name": "ifl-0/0/0/1",
          "authentication-profile": "AUTH_PROFILE_SHA_512_1"
        },
        {
          "name": "ifl-0/0/0/100",
          "metric": 20000,
          "network-type": "p2p",
          "authentication-profile": "AUTH_PROFILE_SHA_512_1"
        },
        {
          "name": "ifl-0/0/1/1",
          "metric": 40000,
          "network-type": "p2p",
          "authentication-profile": "AUTH_PROFILE_SHA_512_1"
        },
        {
          "name": "ifl-0/0/1/100",
          "metric": 30000,
          "authentication-profile": "AUTH_PROFILE_SHA_512_1"
```

```
        },
        {
          "name": "ifl-0/0/4/1",
          "metric": 60000
        },
        {
          "name": "lo-0/0/0/1"
        },
        {
          "name": "lo-0/0/0/2"
        }
      ]
    }
  ]
}
```


To access the RESTCONF API that corresponds to this CLI, click here.

OSPF Interface Configuration

Enable OSPF protocol on the router interfaces.

Syntax:

set instance <instance-name> **protocol ospf address-family** <afi> <attribute> <value>

Attribute	Description
<afi>	Specifies the Address family identifier (AFI), either IPv4 or IPv6.
<afi> instance-id <instance-id>	Specifies the instance ID. When using an IPv6 address family with OSPFv3, an instance ID ranging from 0 to 31 must be specified.
area <area-id> interface <interface-name> ldp-synchronization enable	Enables LDP OSPF Synchronization. By default, LDP OSPF synchronization is disabled.
metric <metric>	Specify the metric value of an OSPF interface.

Attribute	Description
multipath	Specifies the maximum ECMP paths that can be calculated.  The default ECMP Maximum Next-hop Count is limited to 8; however, this limit varies depending on the platform that RBFS supports. For details on the limits set for the ECMP Maximum Next-hop Count on the platforms, refer to the undefined/techdocs/current/platform/resource_limit.html[Resource Limits/Feature Support] section of the *Platform Guide*.
network-type <broadcast | p2p>	broadcast - Sets the network type to broadcast; p2p - Sets the network type to point-to-point. By default, the network-type is broadcast.
router-priority <router-priority>	Sets the router priority for an interface. Allowed range: 0 - 255, Default: 1. Routers with priority value '0' do not participate in the DR or BDR election.
segment-routing index	Sets the prefix segment identifier (SID) index for the specified interface.

Attribute	Description
timer <hello | dead | wait>	Interface timer for configuring hello, dead, and wait timers. • **hello**: Sets interval time for sending hello packets to a neighbor and this time is identical on OSPF neighbor routers. Range: 1-65535 seconds. Default: 10 seconds. • **dead**: Sets interval time within which if the interface does not receive any hello packet from its neighbor, the interface comes to know that the neighbor is down. Range: 4-262140 seconds. Default: 40 seconds. • **wait**: Sets wait time to delay to trigger the DR/BDR election. It cannot be more than the time set for the dead interval. Range: 1-255 seconds. Default: 40 seconds.
mtu-ignore enable	If there is an MTU mismatch on both sides of the link where OSPF runs, the OSPF adjacency will not come up as the MTU value carried in the Database Description (DBD) packets. To avoid MTU validation in the Database Description (DBD) packets, configure mtu-ignore command. By default, it is disabled.
authentication <authentication-profile>	Specifies the authentication profile name used to create an attachment point at the interface level.
no-authentication-check <enable>	When enabled, OSPF packets received here will not undergo authentication validation at the interface level, even if the user has enabled authentication.



If an authentication profile is attached to an interface and an area, the authentication profile attached to the interface takes priority.

Example: OSPF IPv4 Interface Configuration

The following configuration sets up interfaces in the OSPF protocol under the default OSPF instance, within the IPv4 address family and area 0.0.0.0. The interfaces 'ifl-0/0/0/1', 'ifl-0/0/0/100', 'ifl-0/0/1/1', and 'ifl-0/0/1/100' are defined and

they use the same authentication profile 'AUTH_PROFILE_SHA_512_1'.

The interfaces 'ifl-0/0/0/100' and 'ifl-0/0/1/1' are configured as point-to-point links. These interfaces also have custom OSPF metrics set to influence route selection: 20,000 and 40,000 respectively. The interface 'ifl-0/0/1/100' uses the same authentication profile and has a metric of 30,000, although it does not have a specific network type defined. Additionally, the interface 'ifl-0/0/4/1' is configured with a metric of 60,000 but does not employ authentication. The loopback interfaces 'lo-0/0/0/1' and 'lo-0/0/0/2' are included in the OSPF configuration with default settings.

```
set instance default protocol ospf address-family ipv4 area 0.0.0.0 interface ifl-
0/0/0/1 authentication-profile AUTH_PROFILE_SHA_512_1
set instance default protocol ospf address-family ipv4 area 0.0.0.0 interface ifl-
0/0/0/100 metric 20000
set instance default protocol ospf address-family ipv4 area 0.0.0.0 interface ifl-
0/0/0/100 network-type p2p
set instance default protocol ospf address-family ipv4 area 0.0.0.0 interface ifl-
0/0/0/100 authentication-profile AUTH_PROFILE_SHA_512_1
set instance default protocol ospf address-family ipv4 area 0.0.0.0 interface ifl-
0/0/1/1 metric 40000
set instance default protocol ospf address-family ipv4 area 0.0.0.0 interface ifl-
0/0/1/1 network-type p2p
set instance default protocol ospf address-family ipv4 area 0.0.0.0 interface ifl-
0/0/1/1 authentication-profile AUTH_PROFILE_SHA_512_1
set instance default protocol ospf address-family ipv4 area 0.0.0.0 interface ifl-
0/0/1/100 metric 30000
set instance default protocol ospf address-family ipv4 area 0.0.0.0 interface ifl-
0/0/1/100 authentication-profile AUTH_PROFILE_SHA_512_1
set instance default protocol ospf address-family ipv4 area 0.0.0.0 interface ifl-
0/0/4/1 metric 60000
set instance default protocol ospf address-family ipv4 area 0.0.0.0 interface lo-
0/0/0/1
set instance default protocol ospf address-family ipv4 area 0.0.0.0 interface lo-
0/0/0/2
```

```
supervisor@rtbrick>SPINE01: cfg> show config instance default protocol ospf address-family ipv4 area 0.0.0.0
interface
{
  "rtbrick-config:interface": [
    {
      "name": "ifl-0/0/0/1",
      "authentication-profile": "AUTH_PROFILE_SHA_512_1"
    },
    {
      "name": "ifl-0/0/0/100",
      "metric": 20000,
      "network-type": "p2p",
      "authentication-profile": "AUTH_PROFILE_SHA_512_1"
    },
    {
      "name": "ifl-0/0/1/1",
      "metric": 40000,
      "network-type": "p2p",
      "authentication-profile": "AUTH_PROFILE_SHA_512_1"
    },
    {
      "name": "ifl-0/0/1/100",
```

```
      "metric": 30000,
      "authentication-profile": "AUTH_PROFILE_SHA_512_1"
    },
    {
      "name": "ifl-0/0/4/1",
      "metric": 60000
    },
    {
      "name": "lo-0/0/0/1"
    },
    {
      "name": "lo-0/0/0/2"
    }
  ]
}
```

Example: OSPF IPv6 Interface Configuration

This configuration defines OSPFv3 (IPv6) interfaces under the instance 'default', instance ID '0', and the area 0.0.0.0. Each interface is configured with parameters such as metric, network type, and authentication profile. It uses the authentication profile AUTH_PROFILE_SHA_512_1 for interfaces 'ifl-0/0/0/1', 'ifl-0/0/0/100', 'ifl-0/0/1/1', and 'ifl-0/0/1/100'.

Interfaces 'ifl-0/0/0/100' and 'ifl-0/0/1/1' are configured as point-to-point links. These interfaces also have custom OSPF metrics set to influence route selection: 20,000 and 40,000 respectively. The interface 'ifl-0/0/1/100' uses the same authentication profile and has a metric of 30,000. The interface 'ifl-0/0/4/1' is configured with a metric of 60,000 but does not employ authentication. The loopback interfaces 'lo-0/0/0/1' and 'lo-0/0/0/2' are included in the OSPF configuration with default settings.

```
set instance default protocol ospf address-family ipv6 instance-id 0 area 0.0.0.0
interface ifl-0/0/0/1 authentication-profile AUTH_PROFILE_SHA_512_1
set instance default protocol ospf address-family ipv6 instance-id 0 area 0.0.0.0
interface ifl-0/0/0/100 metric 20000
set instance default protocol ospf address-family ipv6 instance-id 0 area 0.0.0.0
interface ifl-0/0/0/100 network-type p2p
set instance default protocol ospf address-family ipv6 instance-id 0 area 0.0.0.0
interface ifl-0/0/0/100 authentication-profile AUTH_PROFILE_SHA_512_1
set instance default protocol ospf address-family ipv6 instance-id 0 area 0.0.0.0
interface ifl-0/0/1/1 metric 40000
set instance default protocol ospf address-family ipv6 instance-id 0 area 0.0.0.0
interface ifl-0/0/1/1 network-type p2p
set instance default protocol ospf address-family ipv6 instance-id 0 area 0.0.0.0
interface ifl-0/0/1/1 authentication-profile AUTH_PROFILE_SHA_512_1
set instance default protocol ospf address-family ipv6 instance-id 0 area 0.0.0.0
interface ifl-0/0/1/100 metric 30000
set instance default protocol ospf address-family ipv6 instance-id 0 area 0.0.0.0
interface ifl-0/0/1/100 authentication-profile AUTH_PROFILE_SHA_512_1
set instance default protocol ospf address-family ipv6 instance-id 0 area 0.0.0.0
interface ifl-0/0/4/1 metric 60000
set instance default protocol ospf address-family ipv6 instance-id 0 area 0.0.0.0
interface lo-0/0/0/1
```

```
set instance default protocol ospf address-family ipv6 instance-id 0 area 0.0.0.0
interface lo-0/0/0/2
```

```
supervisor@rtbrick>SPINE01: cfg> show config instance default protocol ospf address-family ipv6 instance-id 0
area 0.0.0.0 interface
{
  "rtbrick-config:interface": [
    {
      "name": "ifl-0/0/0/1",
      "authentication-profile": "AUTH_PROFILE_SHA_512_1"
    },
    {
      "name": "ifl-0/0/0/100",
      "metric": 20000,
      "network-type": "p2p",
      "authentication-profile": "AUTH_PROFILE_SHA_512_1"
    },
    {
      "name": "ifl-0/0/1/1",
      "metric": 40000,
      "network-type": "p2p",
      "authentication-profile": "AUTH_PROFILE_SHA_512_1"
    },
    {
      "name": "ifl-0/0/1/100",
      "metric": 30000,
      "authentication-profile": "AUTH_PROFILE_SHA_512_1"
    },
    {
      "name": "ifl-0/0/4/1",
      "metric": 60000
    },
    {
      "name": "lo-0/0/0/1"
    },
    {
      "name": "lo-0/0/0/2"
    }
  ]
}
```

API To access the RESTCONF API that corresponds to this CLI, click here.

OSPF Metric Configuration

Metric is the cost that OSPF uses to calculate and identify the best paths to other routers.

Syntax

set instance <instance-name> **protocol ospf address-family** <afi> <attribute> <value>

Attribute	Description
<afi>	Specifies the Address family identifier (AFI), either IPv4 or IPv6.
<afi> instance-id <instance-id>	Specifies the instance ID. When using an IPv6 address family with OSPFv3, an instance ID ranging from 0 to 31 must be specified.
metric <metric>	OSPF address-family metric. Allowed range: 0 - 65535. Default: 10000.  If you configure the metric at the address family, it will be applicable to the configured areas of the address-family. If you configure a metric for an area, this configured metric value will take precedence over the address-family metric configurations of this area. If you specify a metric value for an area on an interface will override any area and address-family metric configurations for this area.

Example 1: OSPF IPv4 Metric Configuration

This configuration sets the OSPF cost (metric) for all interfaces within area 0.0.0.0 (for IPv4 address family) to 1000.

```
set instance default protocol ospf address-family ipv4 area 0.0.0.0 metric 1000
```

```
supervisor@rtbrick>SPINE01: cfg> show config instance default protocol ospf address-family ipv4 area 0.0.0.0
metric
{
  "rtbrick-config:metric": 1000
}
```

Example: OSPF IPv6 Metric Configuration

This configuration sets the OSPFv3 cost (metric) for all interfaces within area 0.0.0.0 (for IPv6 address family) to 1000.

```
set instance default protocol ospf address-family ipv6 instance-id 0  area 0.0.0.0
metric 1000
```

```
supervisor@rtbrick: cfg> show config instance default protocol ospf address-family ipv6 instance-id 0 area
0.0.0.0 metric
{
  "rtbrick-config:metric": 1000
}
```

OSPF Opaque Capability Configuration

Enables opaque link-state advertisements. Routers in the OSPF network can receive and advertise Type-9, Type-10 and Type-11 opaque LSAs.

Syntax

set instance <instance-name> **protocol ospf address-family ipv4** <attribute> <value>

Attribute	Description
opaque-capability <enable | disable>	Enable or disable opaque LSA advertisement and reception. Set as 'enable' to enable the router to receive and advertise opaque LSAs.

Example: OSPF Opaque Capability Configuration

This configuration enables opaque capability for the OSPF IPv4 address family. This configuration allows the exchange of opaque LSAs.

```
set instance default protocol ospf address-family ipv4 opaque-capability enable
```

```
supervisor@rtbrick>: cfg> show config instance default protocol ospf address-family ipv4 opaque-capability
{
  "rtbrick-config:opaque-capability": "enable"
}
```

Segment Routing Configuration

It enables segment routing for OSPF. For configuring segment routing, you must enable the opaque capability by defining it as 'true'. For information, see the section: "Opaque Capability Configuration".

Syntax

set instance <instance-name> **protocol ospf address-family** <afi> <attribute> <value>

Attribute	Description
<afi>	Specifies the Address family identifier (AFI), either IPv4 or IPv6.
<afi> instance-id <instance-id>	Specifies the instance ID. When using an IPv6 address family with OSPFv3, an instance ID ranging from 0 to 31 must be specified.
segment-routing srgb base <value>	Specifies the segment routing global block (SRGB) in source packet routing. SRGB is used for prefix SIDs.
segment-routing srgb range <value>	OSPF system range of labels from the base label. NOTE: For details on the supported label ranges, see the undefined/techdocs/current/platform/resource_limit.html#static-system-dynamic-label-ranges[Static, System, and Dynamic Label Ranges] section in the Platform Guide.
segment-routing status <disable | enable>	Enable or disable the segment routing feature. By default, the status is disabled.

Example: OSPF IPv4 Segment routing Configuration

This configuration enables Segment Routing for the OSPF IPv4 address family. It defines SRGB base as '1000' and the range as '1000'.

```
set instance default protocol ospf address-family ipv4 segment-routing status
enable
set instance default protocol ospf address-family ipv4 segment-routing srgb base
1000
set instance default protocol ospf address-family ipv4 segment-routing srgb range
1000
```

```
supervisor@rtbrick>SPINE01: cfg> show config instance default protocol ospf address-family ipv4 segment-
routing
{
  "rtbrick-config:segment-routing": {
```

```
    "status": "enable",
    "srgb": {
      "base": 1000,
      "range": 1000
    }
  }
}
```

Example: OSPF IPv6 Segment routing Configuration

This configuration enables Segment Routing for the OSPF IPv6 address family. It defines SRGB base as '1000' and the range as '1000'.

```
set instance default protocol ospf address-family ipv6 instance-id 0 segment-
routing status enable
set instance default protocol ospf address-family ipv6 instance-id 0 segment-
routing srgb base 1000
set instance default protocol ospf address-family ipv6 instance-id 0 segment-
routing srgb range 1000
```

```
supervisor@rtbrick>SPINE01: cfg> show config instance default protocol ospf address-family ipv6 instance-id 0
segment-routing
{
  "rtbrick-config:segment-routing": {
    "status": "enable",
    "srgb": {
      "base": 1000,
      "range": 1000
    }
  }
}
```

API To access the RESTCONF API that corresponds to this CLI (OSPF IPv4 Segment routing), click here.

API To access the RESTCONF API that corresponds to this CLI (OSPF IPv6 Segment routing), click here.

OSPF Redistribution Configuration

It enables route redistribution for the routes originating from other sources or protocols such as BGP, Direct, IPoE, IS-IS, PPP, and Static.

Syntax

set instance <instance-name> **protocol ospf** <afi> <attribute> <value>

Attribute	Description
<afi>	Specifies the Address family identifier (AFI), either IPv4 or IPv6.
<afi> instance-id <instance-id>	Specifies the instance ID. When using an IPv6 address family with OSPFv3, an instance ID ranging from 0 to 31 must be specified.
redistribute <protocol>	Specifies the source protocol from which the routes are to be redistributed. The available options include BGP, Direct, IPoE, IS-IS, PPP, and Static.
metric <metric>	Specifies the metric value for the redistributed routes.
metric-type <type 1 | type 2>	Specifies the external metric type for the redistributed routes.
policy	Specifies the name of the policy map. The redistribute attach point allows routes from other sources to be advertised by OSPFv2.

Example: OSPF IPV4 BGP Redistribution Configuration

The following OSPF IPv4 redistribution configuration ensures that BGP-learned routes are injected into OSPF with a defined metric (2000). It ensures routing across protocol boundaries.

```
set instance default protocol ospf address-family ipv4 redistribute bgp
set instance default protocol ospf address-family ipv4 redistribute bgp metric
2000
```

```
supervisor@rtbrick: cfg> show config instance default protocol ospf address-family ipv4 redistribute bgp
{
  "rtbrick-config:redistribute": [
    {
      "source": "bgp",
      "metric": 2000
    }
  ]
}
```

Example: OSPF IPv6 Redistribution Policy

The following IPv6 redistribution policy configuration ensures that only the directly connected routes are allowed to import into OSPFv3 according to the rules defined in ospf_policy_1.

```
set instance default protocol ospf address-family ipv6 instance-id 0 redistribute
source direct policy ospf_policy_1
```

```
supervisor@rtbrick>SPINE01: cfg> show config instance default protocol ospf address-family ipv6 instance-id 0
redistribute direct
{
  "rtbrick-config:redistribute": [
    {
      "source": "direct",
      "policy": "ospf_policy_1"
    }
  ]
}
```

API To access the RESTCONF API that corresponds to this CLI (OSPF IPv4 Redistribution), click here.

API To access the RESTCONF API that corresponds to this CLI (OSPF IPv6 Redistribution), click here.

ECMP Routing Configuration

ECMP (equal-cost multiple paths) routing is a mechanism in which routers forward packets to a destination using the multiple available best paths. This mechanism can increase network bandwidth substantially by load-balancing traffic through multiple best paths.

Syntax

set instance <instance-name> **protocol ospf address-family** <afi> <attribute> <value>

Attribute	Description
<afi>	Specifies the Address family identifier (AFI), either IPv4 or IPv6.
<afi> instance-id <instance-id>	Specifies the instance ID. When using an IPv6 address family with OSPFv3, an instance ID ranging from 0 to 31 must be specified.
<max-load-balance>	Maximum number of equal-cost multiple paths to be calculated for load balancing. Default: 16. Allowed range: 1 - 255.

Example: OSPF IPv4 ECMP Routing Configuration

This configuration specifies a maximum of 100 equal-cost multipath (ECMP) routes that can be installed for the OSPF IPv4 address family.

```
set instance default protocol ospf address-family ipv4 max-load-balance 100
```

```
supervisor@rtbrick: cfg> show config instance default protocol ospf address-family ipv4 max-load-balance
{
  "rtbrick-config:max-load-balance": 100
}
```

Example: OSPF IPv6 ECMP Routing Configuration

This configuration sets OSPF IPv6 ECMP routing. It specifies a maximum of 100 equal-cost multipath (ECMP) routes that can be installed for the OSPF IPv6 address family.

```
set instance default protocol ospf address-family ipv6 instance-id 0 max-load-
balance 100
```

```
supervisor@rtbrick>SPINE01: cfg> show config instance default protocol ospf address-family ipv6 instance-id 0
max-load-balance
{
  "rtbrick-config:max-load-balance": 100
}
```

OSPF Authentication Configuration

OSPF supports the secure exchange of routing updates through authentication. You can enable authentication by attaching an authentication profile at the area or interface level. OSPF allows multiple keys to be attached to prevent session interruption.

The table below shows the authentication types supported by OSPFv2 and v3.

OSPF Authentication Types Supported

Authentication Type	OSPFv2	OSPFv3
Clear Text	Yes	No
HMAC-SHA-1	Yes	Yes
HMAC-SHA-256	Yes	Yes

Authentication Type	OSPFv2	OSPFv3
HMAC-SHA-384	Yes	Yes
HMAC-SHA-512	Yes	Yes
MD5	Yes	No

To authenticate OSPF, there must be a global authentication profile present.

Configuring an Authentication Profile

set authentication-profile <attribute> <value>

Attribute	Description
<name>	Specifies the authentication profile name.
<name> key <key-id>	Specifies the message digest key identifier to be used by the neighboring routers for the OSPF password authentication. Allowed range: 1 - 255.
<name> key <key-id> type <auth-type>	Specifies the type of authentication that is being used, such as MD5, HMAC-SHA-1, and others.
<name> key <key-id> plain-text <text>	Specifies the password in plain text format.
<name> key <key-id> encrypted-text <text>	Specifies the password in an encrypted text format.
<name> key prefer-key-id <key-id>	Preferred key-id configuration will be used while sending out the packet with the specified key.

- When an authentication profile is available, you can configure an authentication attachment point at the area or interface level.
- When an authentication profile contains multiple key-IDs, and the preferred key-ID is not configured, the packet is sent using the highest key-ID.

The authentication profile "auth-profile1" has md5, hmac-sha-1, and clear-text enabled. The preferred key-id being 20, the hmac-sha-1 method will be used for

authentication.

In the following configuration, the authentication profile is defined for each OSPF interface within a specific area. It specifies the authentication profile 'AUTH_PROFILE_SHA_512_1' for OSPF packet authentication and is applied to the interfaces 'ifl-0/0/0/1' and 'ifl-0/0/0/100', ensuring that OSPF neighbors on these interfaces use the same authentication mechanism to securely establish and maintain adjacencies.

This configuration also enables segment routing for this OSPF instance and defines route redistribution into OSPF. It specifies the source protocols (BGP and direct) whose routes will be imported into OSPF.

```
    "rtbrick-config:instance": [
      {
        "name": "default",
        "address-family": [
          {
            "afi": "ipv4",
            "safi": "unicast"
          },
          {
            "afi": "ipv6",
            "safi": "unicast"
          }
        ],
        "protocol": {
          "ospf": {
            "address-family": {
              "ipv6": {
                "instance-id": [
                  {
                    "instance-id": 0,
                    "router-id": "192.168.0.10",
                    "max-load-balance": 100,
                    "metric": 1000,
                    "segment-routing": {
                      "status": "enable",
                      "srgb": {
                        "base": 1000,
                        "range": 1000
                      }
                    },
                    "redistribute": [
                      {
                        "source": "bgp",
                        "metric": 2000
                      },
                      {
                        "source": "direct",
                        "policy": "ospf_policy_1"
                      }
                    ],
                    "area": [
```

```
                        {
                          "area-id": "0.0.0.0",
                          "metric": 1000,
                          "interface": [
                            {
                              "name": "ifl-0/0/0/1",
                              "authentication-profile": "AUTH_PROFILE_SHA_512_1"
                            },
                            {
                              "name": "ifl-0/0/0/100",
                              "metric": 20000,
                              "network-type": "p2p",
                              "authentication-profile": "AUTH_PROFILE_SHA_512_1"
```


API To access the RESTCONF API that corresponds to this CLI, click here.

2.7.3. OSPF Operational Commands

OSPF Show Commands

OSPF Summary

Displays the OSPF protocol summary information.

Syntax:

show ospf summary <options>

Option	Description
-	Without any option, the command displays the information for all instances and address families.
instance <instance-name>	OSPF summary information for the given instance.
instance <instance-name> <afi>	OSPF summary information for the specified instance and address family. Supported AFI values are 'ipv4' and 'ipv6'.
<afi> instance <instance-name>	OSPF summary information for the specified address family and instance. Supported AFI values are 'ipv4' and 'ipv6'.

Example: OSPF summary for the default instance

```
supervisor@rtbrick>SPINE01: op> show ospf summary
Global Information:
  Neighbor State Information:
    Full       : 12
    Loading    : 0
    Exchange   : 0
    ExStart    : 0
    TwoWay     : 2
    Init       : 0
    Attempt    : 0
    Down       : 0
Instance: default, Address family: ipv4
  General information:
    Router ID: 192.168.0.10, Area count: 1, Flood interval: 1000ms
    Opaque capability: True, Segment routing capability: True
    Flags: -|-|-|-|-, Cost: 10000
    SPF initial delay: 50ms, SPF short delay: 200ms, SPF long delay: 5000ms
  Area: 0.0.0.0
    Interface count: 7
      Interface: ifl-0/0/0/1
        Address: 12.0.0.1, State: BDR, Type: broadcast, Priority: 1
        Designated router: 12.0.0.2, Backup designated router: 12.0.0.1
        Hello interval: 10s, Dead interval: 40s
        Cost: 10000, MTU: 1500
      Interface: ifl-0/0/0/100
        Address: 12.1.0.1, State: P2P, Type: p2p, Priority: 1
        Designated router: 0.0.0.0, Backup designated router: 0.0.0.0
        Hello interval: 10s, Dead interval: 40s
        Cost: 20000, MTU: 1500
      Interface: ifl-0/0/1/1
        Address: 12.2.0.0, State: P2P, Type: p2p, Priority: 1
        Designated router: 0.0.0.0, Backup designated router: 0.0.0.0
        Hello interval: 10s, Dead interval: 40s
        Cost: 40000, MTU: 1500
      Interface: ifl-0/0/1/100
        Address: 12.3.0.1, State: BDR, Type: broadcast, Priority: 1
        Designated router: 12.3.0.2, Backup designated router: 12.3.0.1
        Hello interval: 10s, Dead interval: 40s
        Cost: 30000, MTU: 1500
      Interface: ifl-0/0/4/1
        Address: 11.0.0.1, State: DROther, Type: broadcast, Priority: 1
        Designated router: 11.0.0.5, Backup designated router: 11.0.0.4
        Hello interval: 10s, Dead interval: 40s
        Cost: 60000, MTU: 1500
      Interface: lo-0/0/0/1
        Address: 192.168.0.10, State: P2P, Type: p2p, Priority: 1
        Designated router: 0.0.0.0, Backup designated router: 0.0.0.0
        Hello interval: 10s, Dead interval: 40s
        Cost: 10000, MTU:
      Interface: lo-0/0/0/2
        Address: 192.168.0.11, State: P2P, Type: p2p, Priority: 1
        Designated router: 0.0.0.0, Backup designated router: 0.0.0.0
        Hello interval: 10s, Dead interval: 40s
        Cost: 10000, MTU:
Instance: default, Address family: ipv6, Instance ID: 0
  General information:
    Router ID: 192.168.0.10, Area count: 1, Flood interval: 1000ms
    Opaque capability: True, Segment routing capability: True
    Flags: -|-|-|-|-, Cost: 10000
    SPF initial delay: 50ms, SPF short delay: 200ms, SPF long delay: 5000ms
  Area: 0.0.0.0
    Interface count: 7
```

```
      Interface: ifl-0/0/0/1
        Address: fe80::7810:99ff:fec0:0, State: BDR, Type: broadcast, Priority: 1
        Designated router: 192.168.0.20, Backup designated router: 192.168.0.10
        Hello interval: 10s, Dead interval: 40s
        Cost: 10000, MTU: 1500
      Interface: ifl-0/0/0/100
        Address: fe80::65:7810:99ff:fec0:0, State: P2P, Type: p2p, Priority: 1
        Designated router: 0.0.0.0, Backup designated router: 0.0.0.0
        Hello interval: 10s, Dead interval: 40s
        Cost: 20000, MTU: 1500
      Interface: ifl-0/0/1/1
        Address: fe80::7810:99ff:fec0:1, State: P2P, Type: p2p, Priority: 1
        Designated router: 0.0.0.0, Backup designated router: 0.0.0.0
        Hello interval: 10s, Dead interval: 40s
        Cost: 40000, MTU: 1500
      Interface: ifl-0/0/1/100
        Address: fe80::65:7810:99ff:fec0:1, State: BDR, Type: broadcast, Priority: 1
        Designated router: 192.168.0.20, Backup designated router: 192.168.0.10
        Hello interval: 10s, Dead interval: 40s
        Cost: 30000, MTU: 1500
      Interface: ifl-0/0/4/1
        Address: fe80::7810:99ff:fec0:4, State: DROther, Type: broadcast, Priority: 1
        Designated router: 192.168.0.50, Backup designated router: 192.168.0.40
        Hello interval: 10s, Dead interval: 40s
        Cost: 60000, MTU: 1500
      Interface: lo-0/0/0/1
        Address: 192:168::10, State: P2P, Type: p2p, Priority: 1
        Designated router: 0.0.0.0, Backup designated router: 0.0.0.0
        Hello interval: 10s, Dead interval: 40s
        Cost: 10000, MTU: 0
      Interface: lo-0/0/0/2
        Address: 192:168::11, State: P2P, Type: p2p, Priority: 1
        Designated router: 0.0.0.0, Backup designated router: 0.0.0.0
        Hello interval: 10s, Dead interval: 40s
        Cost: 10000, MTU: 0
<...>
```

API To access the Operational State API that corresponds to this CLI, click include::common:partial$operational_api_links.adoc[tag=show_ospf_summary].

OSPF Hostname

Displays the OSPF hostname information.

Syntax:

```
show ospf hostname
```

Example: OSPF hostname for the default instance

```
supervisor@rtbrick>SPINE01: op> show ospf hostname
Instance                      AFI   Instance ID     Router ID              Hostname
default                       ipv4                  192.168.0.10           Router1
```

```
default                        ipv6  0              192.168.0.10           Router1
```

OSPF Interface

Displays OSPF interface information.

Syntax:

show ospf interface <options>

Option	Description
-	Without any option, the command displays the interface information for all instances and address families.
detail	Displays the detailed interface information.
<interface-name> detail	Displays detailed information for the specified interface. Also, for the specified interface, you can display interface information with filter options: detail, ipv4, and ipv4 detail.
instance <instance-name>	OSPF interface information for the given instance. Also, for the specified instance, you can display interface information with filter options: interface name, detail, and ipv4 detail.
instance <instance-name> <interface-name>	Displays information for a specified interface for a given instance.
instance <instance-name> <interface-name> detail	Displays detailed information for a specified interface for a given instance.
<afi>	Displays OSPF interface information for the specified address family. Supported AFI values are 'ipv4' and 'ipv6'. You can display interface information for the specified address family using filters such as interface name, detail, and instance.

Example 1: OSPF interface information for the default instance

```
supervisor@rtbrick>SPINE01: op> show ospf interface
Instance: default, Address family: ipv4
```

```
  Interface            Area            IP Address                    State          Type       Cost
Priority DR              BDR             MTU
  ifl-0/0/0/1       0.0.0.0         12.0.0.1                      BDR            broadcast  10000    1
12.0.0.2        12.0.0.1        1500
  ifl-0/0/0/100     0.0.0.0         12.1.0.1                      P2P            p2p        20000    1
0.0.0.0         0.0.0.0         1500
  ifl-0/0/1/1       0.0.0.0         12.2.0.0                      P2P            p2p        40000    1
0.0.0.0         0.0.0.0         1500
  ifl-0/0/1/100     0.0.0.0         12.3.0.1                      BDR            broadcast  30000    1
12.3.0.2        12.3.0.1        1500
  ifl-0/0/4/1       0.0.0.0         11.0.0.1                      DROther        broadcast  60000    1
11.0.0.5        11.0.0.4        1500
  lo-0/0/0/1           0.0.0.0         192.168.0.10                  P2P            p2p        10000    1
0.0.0.0         0.0.0.0
  lo-0/0/0/2           0.0.0.0         192.168.0.11                  P2P            p2p        10000    1
0.0.0.0         0.0.0.0
Instance: default, Address family: ipv6, Instance ID: 0
  Interface            Area            IP Address                    State          Type       Cost
Priority DR              BDR             MTU
  ifl-0/0/0/1       0.0.0.0         fe80::7810:99ff:fec0:0        BDR            broadcast  10000    1
192.168.0.20    192.168.0.10    1500
  ifl-0/0/0/100     0.0.0.0         fe80::65:7810:99ff:fec0:0     P2P            p2p        20000    1
0.0.0.0         0.0.0.0         1500
  ifl-0/0/1/1       0.0.0.0         fe80::7810:99ff:fec0:1        P2P            p2p        40000    1
0.0.0.0         0.0.0.0         1500
  ifl-0/0/1/100     0.0.0.0         fe80::65:7810:99ff:fec0:1     BDR            broadcast  30000    1
192.168.0.20    192.168.0.10    1500
  ifl-0/0/4/1       0.0.0.0         fe80::7810:99ff:fec0:4        DROther        broadcast  60000    1
192.168.0.50    192.168.0.40    1500
  lo-0/0/0/1           0.0.0.0         192:168::10                   P2P            p2p        10000    1
0.0.0.0         0.0.0.0         0
  lo-0/0/0/2           0.0.0.0         192:168::11                   P2P            p2p        10000    1
0.0.0.0         0.0.0.0         0
```

Example 2: OSPF interface detailed information

```
supervisor@rtbrick>SPINE01: cfg> show ospf interface ifl-0/0/1/100 detail
Instance: default, Address family: ipv4
  Interface            Area            IP Address                    State          Type       Cost
Priority DR              BDR             MTU
  ifl-0/0/1/100     0.0.0.0         12.3.0.1                      BDR            broadcast  30000    1
12.3.0.2        12.3.0.1        1500
Instance: default, Address family: ipv6, Instance ID: 0
  Interface            Area            IP Address                    State          Type       Cost
Priority DR              BDR             MTU
  ifl-0/0/1/100     0.0.0.0         fe80::65:7810:99ff:fec0:1     BDR            broadcast  30000    1
192.168.0.20    192.168.0.10    1500
```

API To access the Operational State API that corresponds to this CLI, click include::common:partial$operational_api_links.adoc[tag=show_ospf_interface].

OSPF Neighbor

Displays OSPF neighbor information.

Syntax:

show ospf neighbor <options>

Option	Description
-	Without any option, the command displays the neighbor information for all instances.
instance <instance-name>	OSPF neighbor information for the given instance.
area <area-id>	OSPF neighbor information for the given area.
detail	Displays the detailed neighbor information.
interface <interface-name>	Displays the neighbor information for a specified interface.
instance <instance-name> detail	Displays detailed OSPF neighbor information for the given instance.
instance <instance-name> interface <interface-name>	Displays OSPF neighbor information for the specified interface for the given instance.
instance <instance-name> interface <interface-name> detail	Displays detailed OSPF neighbor information for the specified interface for the given instance.
interface <interface-name> detail	Displays detailed neighbor information for a specified interface.
<afi>	Displays OSPF neighbor information for the specified address family. Supported AFI values are 'ipv4' and 'ipv6'. You can display neighbor information for the specified address family using filters such as interface name, detail, and instance.
log	Logs neighbor event information.

Example: OSPF neighbor information for the default instance

```
supervisor@rtbrick>SPINE01: op> show ospf neighbor
Instance: default, Address family: ipv4
  Address                       Interface           Router          Area            State      Priority  DR
   BDR             Uptime         Expires
  12.0.0.2                      ifl-0/0/0/1       192.168.0.20    0.0.0.0         Full       1
12.0.0.2        12.0.0.1       0d:01h:38m:12s  33s
  12.2.0.1                      ifl-0/0/1/1       192.168.0.20    0.0.0.0         Full       1
0.0.0.0         0.0.0.0        0d:01h:38m:57s  33s
  11.0.0.3                      ifl-0/0/4/1       192.168.0.30    0.0.0.0         TwoWay     1
11.0.0.5        11.0.0.4       never           34s
  11.0.0.4                      ifl-0/0/4/1       192.168.0.40    0.0.0.0         Full       1
11.0.0.5        11.0.0.4       0d:01h:38m:11s  34s
  11.0.0.5                      ifl-0/0/4/1       192.168.0.50    0.0.0.0         Full       1
11.0.0.5        11.0.0.4       0d:01h:38m:16s  34s
  12.1.0.2                      ifl-0/0/0/100     192.168.0.20    0.0.0.0         Full       1
0.0.0.0         0.0.0.0        0d:01h:38m:57s  33s
```

```
  12.3.0.2                      ifl-0/0/1/100     192.168.0.20    0.0.0.0         Full       1
12.3.0.2        12.3.0.1        0d:01h:38m:12s  33s
Instance: default, Address family: ipv6, Instance ID: 0
  Address                       Interface           Router          Area            State      Priority  DR
   BDR             Uptime         Expires
  fe80::7845:9aff:fec0:0        ifl-0/0/0/1       192.168.0.20    0.0.0.0         Full       1
192.168.0.20    192.168.0.10    0d:01h:38m:12s  33s
  fe80::7845:9aff:fec0:1        ifl-0/0/1/1       192.168.0.20    0.0.0.0         Full       1
0.0.0.0         0.0.0.0         0d:01h:38m:52s  33s
  fe80::780d:96ff:fec0:4        ifl-0/0/4/1       192.168.0.30    0.0.0.0         TwoWay     1
192.168.0.50    192.168.0.40    never           34s
  fe80::7801:34ff:fec0:5        ifl-0/0/4/1       192.168.0.40    0.0.0.0         Full       1
192.168.0.50    192.168.0.40    0d:01h:38m:16s  34s
  fe80::7865:1aff:fec0:6        ifl-0/0/4/1       192.168.0.50    0.0.0.0         Full       1
192.168.0.50    192.168.0.40    0d:01h:38m:16s  34s
  fe80::65:7845:9aff:fec0:0     ifl-0/0/0/100     192.168.0.20    0.0.0.0         Full       1
0.0.0.0         0.0.0.0         0d:01h:38m:52s  33s
  fe80::65:7845:9aff:fec0:1     ifl-0/0/1/100     192.168.0.20    0.0.0.0         Full       1
192.168.0.20    192.168.0.10    0d:01h:38m:12s  33s
```

API To access the Operational State API that corresponds to this CLI, click include::common:partial$operational_api_links.adoc[tag=show_ospf_neighbor].

OSPF Segment Routing

OSPF Segment Routing Prefix Segment

Displays OSPF segment routing prefix segment information.

Syntax:

show ospf segment-routing prefix-segment <options>

Option	Description
-	Without any option, the command displays the neighbor information for all instances.
prefix-segment	Displays the OSPF prefix segment information
prefix-segment <instance>	Displays the OSPF prefix segments for the specified instance and address family
prefix-segment <instance-name> <afi>	Displays Segment routing global block (SRGB) information for the specified instance address family. Supported AFI values are 'ipv4' and 'ipv6'.

Example: OSPF neighbor information for the default instance

```
supervisor@rtbrick: op> show ospf segment-routing prefix-segment
Instance: default, Address family: ipv4, Area ID: 0.0.0.0
```

```
  Advertising Router        Prefix                            SID   Flags
  Router1                   192.168.0.10/32                 100     0
Instance: default, Address family: ipv6, Instance ID: 0, Area ID: 0.0.0.0
  Advertising Router        Prefix                            SID   Flags
  Router1                   192:168::10/128                 500     0
```

OSPF Segment Routing Global Block

Displays OSPF segment routing global block (SRGB) information.

Syntax:

show ospf segment-routing global-block <options>

Option	Description
-	Without any option, the command displays the neighbor information for all instances.
global-block	Displays Segment routing global block (SRGB) information
global-block instance <instance-name>	Displays Segment routing global block (SRGB) information for the specified instance
global-block instance <instance-name> <afi>	Displays Segment routing global block (SRGB) information for the specified instance address family. Supported AFI values are 'ipv4' and 'ipv6'.

Example: OSPF neighbor information for the default instance

```
supervisor@rtbrick: op> show ospf segment-routing global-block
Instance: default, Address family: ipv4, Area ID: 0.0.0.0
  Advertising Router        SRGB Base   SRGB Range
  Router1                       10000         1000
Instance: default, Address family: ipv6, Instance ID: 0, Area ID: 0.0.0.0
  Advertising Router        SRGB Base   SRGB Range
  Router1                       30000         1000
```

OSPF Database

Displays information from OSPF link-state database that contains data about link-state advertisements (LSAs).

Syntax:

show ospf database <options>

Option	Description
advertising-router <router-id>	Displays LSDB information for the specified advertising router.
advertising-router <router-id> detail	Displays the detailed LSDB information for the specified advertising router.
advertising-router <router-id> ls-id <ls-id>	Displays the LSDB information for the specified link-state ID for the advertising router.
advertising-router <router-id> ls-type external	Displays the LSDB information for the specified LSA type for the advertising router. Link-state advertisement types include external, network, router, and summary.
detail	Displays detailed information from LSDB.
instance <instance-name>	Displays OSPF database information for the given instance.
ls-id <ls-id>	OSPF database information for a specific link-state identifier.
ls-type <type>	OSPF database information for the specified link-state type. Link-state advertisement types include external, network, router and summary.
area <area-id>	Displays database information for the specified OSPF area.
area <area-id> advertising-router <router-id>	Displays LSDB information for the specified advertising router for a specified OSPF area.
area <area-id> detail	Displays detailed LSDB information for the specified OSPF area.
area <area-id> ls-id <ls-id>	Displays LSDB information for the specified link-state identifier for the specified OSPF area.

Option	Description
area <area-id> ls-type <type>	Displays LSDB information for the specified link-state type for the specified OSPF area. Link-state advertisement types include external, network, router, and summary.
instance <instance-name> advertising router <router-id>	Displays LSDB information for the specified advertising router for the given instance.
instance <instance-name> area <area-id>	Displays LSDB information for the specified area for the given instance.
instance <instance-name> ls-id <ls-id>	Displays LSDB information for the specified link-state identifier for the given instance.
instance <instance-name> ls-type <type>	Displays LSDB information for the specified type of the given instance. Link-state advertisement types include external, network, router and summary.
<afi>	Displays LSDB neighbor information for the specified address family. Supported AFI values are 'ipv4' and 'ipv6'. You can display LSDB information for the specified address family using filters such as interface name, detail, and instance.

Example 1: OSPF database information for the default instance

```
supervisor@rtbrick>SPINE01: cfg> show ospf database
Instance: default, Address family: ipv4, Area: 0.0.0.0
  Type                    Link State ID   Advertising Router          Age        Sequence   Checksum
Cost
  Router                  192.168.0.10    192.168.0.10                578      0x80000008     0x262a
-
  Router                  192.168.0.20    192.168.0.20                579      0x80000009     0xddd7
-
  Router                  192.168.0.30    192.168.0.30                584      0x80000007     0x92be
-
  Network                 11.0.0.5        192.168.0.50                583      0x80000004     0xc9b1
-
  Network                 12.0.0.2        192.168.0.20                579      0x80000004     0x7962
-
  Network                 12.3.0.2        192.168.0.20                579      0x80000004     0xdc7a
-
  Network                 23.0.0.3        192.168.0.30                585      0x80000004     0x9917
-
  Summary-Network         24.0.1.0        192.168.0.20                623      0x80000004     0xbc36
15000
  Summary-Network         24.0.1.0        192.168.0.40                623      0x80000004     0x449a
15000
  Summary-Network         24.0.1.0        192.168.0.50                578      0x80000005      0x795
25000
Instance: default, Address family: ipv4
  Type                    Link State ID   Advertising Router          Age        Sequence   Checksum
Cost
```

```
  External                200.0.1.0       192.168.0.60               619      0x80000004     0xba29
16777214
  External                200.0.1.60      192.168.0.60               619      0x80000004     0x6047
16777214
  External                200.0.1.61      192.168.0.60               619      0x80000004     0x5650
16777214
Instance: default, Address family: ipv6, Instance ID: 0, Area: 0.0.0.0
  Type                    Link State ID   Advertising Router         Age        Sequence   Checksum
Cost
  OSPFv3-Router           0.0.0.0         192.168.0.10               578      0x80000007     0xb041
-
  OSPFv3-Router           0.0.0.0         192.168.0.20               579      0x80000007     0x1085
-
  OSPFv3-Router           0.0.0.0         192.168.0.30               580      0x80000007      0xe89
-
  Inter-Area-Prefix       1.0.0.0         192.168.0.20               624      0x80000004     0xd4b7
15000
  Inter-Area-Prefix       1.0.0.0         192.168.0.30               624      0x80000004     0x2208
25000
  Inter-Area-Prefix       1.0.0.0         192.168.0.40               623      0x80000004     0x5c1c
15000
  Inter-Area-Prefix       1.0.0.0         192.168.0.50               623      0x80000004     0xf9ee
10000
  Intra-Area-Prefix       1.0.0.0         192.168.0.10               578      0x80000006     0x7af2
-
  Intra-Area-Prefix       1.0.0.0         192.168.0.20               579      0x80000005     0xf646
-
  Intra-Area-Prefix       1.0.0.0         192.168.0.30               580      0x80000006     0x56b2
-
  Link                    6.0.8.0         192.168.0.10               583      0x80000005     0x7d82
-
  Link                    6.0.8.0         192.168.0.20               584      0x80000005     0xa51a
-
  Link                    6.0.32.3        192.168.0.10               623      0x80000004     0x17d2
-
  Link                    6.0.32.3        192.168.0.20               624      0x80000004     0x3f6a
-
Instance: default, Address family: ipv6, Instance ID: 0
  Type                    Link State ID   Advertising Router         Age        Sequence   Checksum
Cost
  OSPFv3-External         1.0.0.0         192.168.0.60               619      0x80000004     0xa367
16777214
  OSPFv3-External         2.0.0.0         192.168.0.60               619      0x80000004     0x738a
16777214
<...>
```

Example 2: OSPF database detailed information

```
supervisor@rtbrick>SPINE01: cfg> show ospf database detail
Instance: default, Address family: ipv4, Area: 0.0.0.0 LSAs
  LSA ID: 192.168.0.10
    Advertising router: 192.168.0.10, LSA type: Router
    Sequence number: 0x80000008, Checksum: 0x262a, LSA age: 719s
    Length: 132, Options: *|-|-|-|-|-|E|*, Flags: -|-|-|-
    Number of links: 9
      Link ID: 12.0.0.2
        Link data: 12.0.0.1, Type: Transit
        Type of service: 0, Metric: 10000
      Link ID: 192.168.0.20
        Link data: 12.1.0.1, Type: P2P
        Type of service: 0, Metric: 20000
      Link ID: 12.1.0.0
        Link data: 255.255.255.252, Type: Stub
        Type of service: 0, Metric: 20000
      Link ID: 192.168.0.20
        Link data: 12.2.0.0, Type: P2P
        Type of service: 0, Metric: 40000
      Link ID: 12.2.0.0
```

```
        Link data: 255.255.255.254, Type: Stub
        Type of service: 0, Metric: 40000
      Link ID: 12.3.0.2
        Link data: 12.3.0.1, Type: Transit
        Type of service: 0, Metric: 30000
      Link ID: 11.0.0.5
        Link data: 11.0.0.1, Type: Transit
        Type of service: 0, Metric: 60000
      Link ID: 192.168.0.10
        Link data: 255.255.255.255, Type: Stub
        Type of service: 0, Metric: 10000
      Link ID: 192.168.0.11
        Link data: 255.255.255.255, Type: Stub
        Type of service: 0, Metric: 10000
  LSA ID: 192.168.0.20
    Advertising router: 192.168.0.20, LSA type: Router, Router ID: 192.168.0.20
    Sequence number: 0x80000009, Checksum: 0xddd7, LSA age: 720s
    Interface: ifl-0/0/0/100, Neighbor address: 12.1.0.2
    Length: 156, Options: *|-|-|-|-|-|E|*, Flags: -|-|-|B
    Number of links: 11
      Link ID: 12.0.0.2
        Link data: 12.0.0.2, Type: Transit
        Type of service: 0, Metric: 10000
      Link ID: 192.168.0.10
        Link data: 12.1.0.2, Type: P2P
        Type of service: 0, Metric: 20000
      Link ID: 12.1.0.0
        Link data: 255.255.255.252, Type: Stub
        Type of service: 0, Metric: 20000
<...>
```

Example 3: OSPF database for an advertising router

```
supervisor@rtbrick>SPINE01: cfg> show ospf database advertising-router 192.168.0.10
Instance: default, Address family: ipv4, Area: 0.0.0.0
  Type                    Link State ID   Advertising Router          Age        Sequence   Checksum
Cost
  Router                  192.168.0.10    192.168.0.10                791      0x80000008     0x262a
-
Instance: default, Address family: ipv6, Instance ID: 0, Area: 0.0.0.0
  Type                    Link State ID   Advertising Router          Age        Sequence   Checksum
Cost
  OSPFv3-Router           0.0.0.0         192.168.0.10                791      0x80000007     0xb041
-
  Intra-Area-Prefix       1.0.0.0         192.168.0.10                791      0x80000006     0x7af2
-
  Link                    6.0.8.0         192.168.0.10                796      0x80000005     0x7d82
-
  Link                    6.0.32.3        192.168.0.10                836      0x80000004     0x17d2
-
  Link                    6.8.8.0         192.168.0.10                836      0x80000004     0x677e
-
  Link                    6.8.32.3        192.168.0.10                836      0x80000004     0x2b9b
-
  Link                    6.32.8.0        192.168.0.10                795      0x80000006     0x3893
-
```

OSPF SPF Result

Displays SPF results.

Syntax:

show ospf spf result <options>

Option	Description
-	Without any option, the command displays the SPF result of all instances.
area <area-id>	Displays SPF result for the specified area.
instance <instance-name>	Name of the instance
node-id <node-id>	Displays SPF result for the specified node identifier.
area <area-id> <node-id>	Displays SPF result for the specified node identifier for a specified area.
instance <instance-name> area <area-id>	Displays SPF result for the specified area for a given instance.
instance <instance-name> node-id <node-id>	Displays SPF result for the specified node identifier for a given instance.
<afi>	Displays SPF result information for the specified address family. Supported AFI values are 'ipv4' and 'ipv6'. You can display SPF result information for the specified address family using filters such as interface name, detail, and instance.

Example 1: OSPF SPF Result for the default instance

```
supervisor@rtbrick>SPINE01: op> show ospf spf result
Instance: default, Address family: ipv4, Area: 0.0.0.0
  Node ID         Type            Cost     Advertising Router  Flags        Neighbor Node         Interface
Nexthop
  12.0.0.2        network         10000    192.168.0.20        -|-|-|-      -                     local
-
  12.3.0.2        network         30000    192.168.0.20        -|-|-|-      -                     local
-
  23.0.0.3        network         20000    192.168.0.30        -|-|-|-      192.168.0.20          ifl-0/0/0/1
12.0.0.2
  11.0.0.5        network         55000    192.168.0.50        -|-|-|-      192.168.0.20          ifl-0/0/0/1
12.0.0.2
  192.168.0.10    router          0        192.168.0.10        -|-|-|-      -                     local
-
  192.168.0.20    router          10000    192.168.0.20        -|-|-|B      192.168.0.20          ifl-0/0/0/1
12.0.0.2
  192.168.0.30    router          20000    192.168.0.30        -|-|-|B      192.168.0.20          ifl-0/0/0/1
12.0.0.2
  192.168.0.40    router          55000    192.168.0.40        -|-|-|B      192.168.0.20          ifl-0/0/0/1
12.0.0.2
  192.168.0.50    router          55000    192.168.0.50        -|-|-|B      192.168.0.20          ifl-0/0/0/1
12.0.0.2
```

```
Instance: default, Address family: ipv6, Area: 0.0.0.0, Instance ID: 0
  Node ID         Type            Cost     Advertising Router  Flags        Neighbor Node         Interface
Nexthop
  192.168.0.10    router          0        192.168.0.10        -|-|-|-      -                     local
-
  6.0.8.0         network         10000    192.168.0.20        -|-|-|-      -                     local
-
  6.8.32.3        network         30000    192.168.0.20        -|-|-|-      -                     local
-
  192.168.0.20    router          10000    192.168.0.20        -|-|-|B      192.168.0.20          ifl-0/0/0/1
fe80::7845:9aff:fec0:0
  6.0.8.0         network         20000    192.168.0.30        -|-|-|-      192.168.0.20          ifl-0/0/0/1
fe80::7845:9aff:fec0:0
  192.168.0.30    router          20000    192.168.0.30        -|-|-|B      192.168.0.20          ifl-0/0/0/1
fe80::7845:9aff:fec0:0
  192.168.0.40    router          55000    192.168.0.40        -|-|-|B      192.168.0.20          ifl-0/0/0/1
fe80::7845:9aff:fec0:0
  6.48.8.0        network         55000    192.168.0.50        -|-|-|-      192.168.0.20          ifl-0/0/0/1
fe80::7845:9aff:fec0:0
  192.168.0.50    router          55000    192.168.0.50        -|-|-|B      192.168.0.20          ifl-0/0/0/1
fe80::7845:9aff:fec0:0
```

Example 2: OSPF SPF Result for the specified node identifier for the given area

```
supervisor@rtbrick>SPINE01: op> show ospf spf result area 0.0.0.0 node-id 192.168.0.10
Instance: default, Address family: ipv4, Area: 0.0.0.0
  Node ID         Type            Cost     Advertising Router  Flags        Neighbor Node         Interface
Nexthop
  192.168.0.10    router          0        192.168.0.10        -|-|-|-      -                     local
-
Instance: default, Address family: ipv6, Area: 0.0.0.0, Instance ID: 0
  Node ID         Type            Cost     Advertising Router  Flags        Neighbor Node         Interface
Nexthop
  192.168.0.10    router          0        192.168.0.10        -|-|-|-      -                     local
-
```

OSPF SPF Log

Displays SPF Log information.

Syntax:

show ospf spf log <options>

Option	Description
-	Without any option, the command displays the SPF log of all instances.
instance <instance-name>	Displays SPF log for the specified instance.

Option	Description
<afi>	Displays SPF log information for the specified address family. Supported AFI values are 'ipv4' and 'ipv6'. You can display SPF log information for the specified address family using filters such as interface name, detail, and instance.

Example 1: OSPF SPF Result for the default instance

```
supervisor@rtbrick>SPINE01: op> show ospf spf log
Instance: default
  Router ID: 192.168.0.10
    Schedule timestamp: 2024-04-30 11:19:51, Area ID: 0.0.0.0, LSA type: Router
    Reason: Router LSA change, Back off timer: 50, LSA count: 1
    LS ID: 0.0.0.0, Number of schedule request: 1
    SPF start time: 2024-04-30 11:19:51, Number of nodes: 1, Number of links: 0
    Number of stub links: 0, SPF init time: 31us, SPF run time: 394us
    Router LSA change count: 1, Network LSA change count: -
    Prefix changes: -, Sequence number: 1
  Router ID: 192.168.0.10
    Schedule timestamp: 2024-04-30 11:19:51, Area ID: 0.0.0.0, LSA type: Router
    Reason: Router LSA change, Back off timer: 50, LSA count: 1
    LS ID: 192.168.0.10, Number of schedule request: 1
    SPF start time: 2024-04-30 11:19:51, Number of nodes: 1, Number of links: 0
    Number of stub links: 7, SPF init time: 7us, SPF run time: 311us
    Router LSA change count: 1, Network LSA change count: -
    Prefix changes: -, Sequence number: 2
  Router ID: 192.168.0.10
    Schedule timestamp: 2024-04-30 11:19:51, Area ID: 0.0.0.0, LSA type: Link
    Reason: Unknown map - (value) 0xa, Back off timer: 200, LSA count: 5
    LS ID: 6.0.8.0, Number of schedule request: 5
    SPF start time: 2024-04-30 11:19:51, Number of nodes: 1, Number of links: 0
    Number of stub links: 0, SPF init time: 7us, SPF run time: 172us
    Router LSA change count: 1, Network LSA change count: -
    Prefix changes: -, Sequence number: 3
  Router ID: 192.168.0.20
    Schedule timestamp: 2024-04-30 11:19:51, Area ID: 0.0.0.0, LSA type: Router
    Reason: Router LSA change, Back off timer: 5000, LSA count: 6
    LS ID: 192.168.0.20, Number of schedule request: 6
    SPF start time: 2024-04-30 11:19:56, Number of nodes: 3, Number of links: 6
    Number of stub links: 20, SPF init time: 35us, SPF run time: 182us
    Router LSA change count: 7, Network LSA change count: -
    Prefix changes: -, Sequence number: 4
<...>
```

OSPF Route

Displays OSPF routing table information.

Syntax:

show ospf route <options>

Option	Description
-	Without any option, the command displays the OSPF route information for all instances.
area <area-id>	OSPF route information for the given area.
instance <instance-name>	OSPF route information for the given instance.
instance <instance-name> <afi>	Displays OSPF route information for the specified address family and instance. Supported AFI values are 'ipv4' and 'ipv6'.
instance <instance-name> <afi> <safi>	Displays OSPF route information for the specified address family (AFI), sub-address family (SAFI), and instance. Supported AFI values are 'ipv4' and 'ipv6'. Supported SAFI values are 'unicast', and 'labeled-unicast''.
instance <instance-name> label <label>	Displays OSPF route information for the specified label and instance.
instance <instance-name> mpls unicast label <label> | type <type>	Displays OSPF route information for the specified MPLS unicast label or type for the instance.
prefix <ip>	Displays OSPF route information for the specified match prefix.
type <type>	Displays information for OSPF route type. The route types include external-type-1, external-type-2, inter-area, intra-area, and ospf-direct.
<afi> <safi>	Displays OSPF route information for the specified address family (AFI) and sub-address family (SAFI). Supported AFI values are 'ipv4' and 'ipv6'. Supported SAFI values are 'unicast', and 'labeled-unicast''
label <label>	Displays information about the OSPF-labeled routes.
mpls unicast <label | type>	Displays information about OSPF MPLS routes.

Option	Description
area-border	Displays the OSPF Area Border Router (ABR) information. Refer to section "3.1.7. OSPF Route ABR" for the interface configuration details.
autonomous-system-boundary	Displays Autonomous System Border Router information. Refer to section "3.1.7. OSPF Route ABR" for the interface configuration details.

Example: OSPF route information for the default instance

```
supervisor@rtbrick>SPINE01: op> show ospf route
Instance: default, AFI: ipv4, SAFI: unicast
  Prefix                    Area            Type            Cost      Next Hop        Interface
  11.0.0.0/24               0.0.0.0         intra-area      55000     12.0.0.2        ifl-0/0/0/1
  12.0.0.0/23               0.0.0.0         ospf-direct     10000     n/a             local
  12.1.0.0/30               0.0.0.0         ospf-direct     20000     n/a             local
  12.2.0.0/31               0.0.0.0         ospf-direct     40000     n/a             local
  12.3.0.0/17               0.0.0.0         ospf-direct     30000     n/a             local
  23.0.0.0/24               0.0.0.0         intra-area      20000     12.0.0.2        ifl-0/0/0/1
  23.1.0.0/24               0.0.0.0         intra-area      25000     12.0.0.2        ifl-0/0/0/1
  24.0.1.0/24               0.0.0.0         inter-area      25000     12.0.0.2        ifl-0/0/0/1
  24.1.1.0/24               0.0.0.0         inter-area      20000     12.0.0.2        ifl-0/0/0/1
  25.0.1.0/24               0.0.0.0         inter-area      35000     12.0.0.2        ifl-0/0/0/1
  192.168.0.10/32           0.0.0.0         ospf-direct     10000     n/a             local
  192.168.0.11/32           0.0.0.0         ospf-direct     10000     n/a             local
  192.168.0.20/32           0.0.0.0         intra-area      20000     12.0.0.2        ifl-0/0/0/1
  192.168.0.21/32           0.0.0.0         intra-area      20000     12.0.0.2        ifl-0/0/0/1
  200.0.1.60/32                             external-type-1 16777215  12.0.0.2        ifl-0/0/0/1
  200.0.1.61/32                             external-type-1 16777215  12.0.0.2        ifl-0/0/0/1
  200.0.1.0/24                              external-type-1 16777215  12.0.0.2        ifl-0/0/0/1
  200.0.2.60/32                             external-type-1 16777215  12.0.0.2        ifl-0/0/0/1
  200.0.2.61/32                             external-type-1 16777215  12.0.0.2        ifl-0/0/0/1
  200.0.2.0/24                              external-type-1 16777215  12.0.0.2        ifl-0/0/0/1
Instance: default, AFI: ipv6, SAFI: unicast, Instance ID: 0
  Prefix                                      Area            Type            Cost      Next Hop
                Interface
  11::/64                                     0.0.0.0         intra-area      55000
fe80::7845:9aff:fec0:0                      ifl-0/0/0/1
  12::/64                                     0.0.0.0         ospf-direct     10000     n/a
                local
  12:1::/64                                   0.0.0.0         ospf-direct     20000     n/a
                local
  12:2::/64                                   0.0.0.0         ospf-direct     40000     n/a
                local
  23::/64                                     0.0.0.0         intra-area      20000
fe80::7845:9aff:fec0:0                      ifl-0/0/0/1
  24:0:1::/64                                 0.0.0.0         inter-area      25000
fe80::7845:9aff:fec0:0                      ifl-0/0/0/1
  24:1:1::/64                                 0.0.0.0         inter-area      20000
fe80::7845:9aff:fec0:0                      ifl-0/0/0/1
  25:0:1::/64                                 0.0.0.0         inter-area      35000
fe80::7845:9aff:fec0:0                      ifl-0/0/0/1
  25:1:1::/64                                 0.0.0.0         inter-area      40000
fe80::7845:9aff:fec0:0                      ifl-0/0/0/1
<...>
```

OSPF Route Area Border

Displays the OSPF Area Border Router (ABR) information.

Syntax:

```
show ospf route area-border
```

Example: OSPF Route ABR information

```
supervisor@rtbrick>SPINE01: cfg> show ospf route area-border
  192.168.0.20    10000    192.168.0.20        -|-|-|B      ifl-0/0/0/1
12.0.0.2
  192.168.0.30    20000    192.168.0.30        -|-|-|B      ifl-0/0/0/1
12.0.0.2
  192.168.0.40    55000    192.168.0.40        -|-|-|B      ifl-0/0/0/1
12.0.0.2
  192.168.0.50    55000    192.168.0.50        -|-|-|B      ifl-0/0/0/1
12.0.0.2
  192.168.0.20    10000    192.168.0.20        -|-|-|B      ifl-0/0/0/1
fe80::7845:9aff:fec0:0
  192.168.0.30    20000    192.168.0.30        -|-|-|B      ifl-0/0/0/1
fe80::7845:9aff:fec0:0
  192.168.0.40    55000    192.168.0.40        -|-|-|B      ifl-0/0/0/1
fe80::7845:9aff:fec0:0
  192.168.0.50    55000    192.168.0.50        -|-|-|B      ifl-0/0/0/1
fe80::7845:9aff:fec0:0
```

OSPF Route Autonomous System Boundary

Displays Autonomous System Boundary Router information.

Syntax:

```
show ospf route autonomous-system-boundary
```

Example: OSPF Route ASBR information

```
supervisor@rtbrick>SPINE01: cfg> show ospf route autonomous-system-boundary
Instance: default, Address family: ipv4
  Node ID         Cost     Advertising Router  Flags        Interface
Nexthop
  192.168.0.60    40000    192.168.0.20                     ifl-0/0/0/1
12.0.0.2
Instance: default, Address family: ipv6, Instance ID: 0
  Node ID         Cost     Advertising Router  Flags        Interface
Nexthop
  192.168.0.60    40000    192.168.0.20                     ifl-0/0/0/1
fe80::7845:9aff:fec0:0
```

OSPF LSA Request List

Displays the list of all link-state advertisements (LSAs) requests that have been sent or received by a router.

Syntax:

show ospf request-list <options>

Option	Description
-	Without any option, this command displays the list of all link-state advertisement (LSA) requests that have been sent from the router.
detail	Provides detailed information on the requests that have been sent from the router.
area <area-id>	OSPF request-list information for the given area.
instance <instance-name>	OSPF request-list information for the given instance.
<afi>	Displays request-list information for the specified address family. Supported AFI values are 'ipv4' and 'ipv6'.

Example 1: OSPF LSA requests sent to a neighbor

```
supervisor@rtbrick>SPINE01: op> show ospf request-list
Instance: default
  Type            Link State ID   Advertising Router          Age        Sequence   Checksum
  Summary-Network 11.0.0.0        198.51.100.20                 42      0x80000003     0x76e5
  Summary-Network 12.0.0.0        198.51.100.20                 42      0x80000003     0x603d
  Summary-Network 12.1.0.0        198.51.100.20                 42      0x80000003     0x481f
  Summary-Network 12.2.0.0        198.51.100.20                 42      0x80000003     0x4aab
  Summary-Network 12.3.0.0        198.51.100.20                 42      0x80000003     0xc5e4
  Summary-Network 23.0.0.0        198.51.100.20                 42      0x80000003     0xd5bb
  Summary-Network 23.1.0.0        198.51.100.20                 42      0x80000003     0xca2a
```

Example 2: Detailed information for OSPF LSA requests sent to a neighbor

```
supervisor@rtbrick>SPINE01: op> show ospf request-list detail
Instance: default LSAs
  LSA ID: 11.0.0.0
    Advertising router: 198.51.100.20, LSA type: Summary-Network, Router ID: 192.168.0.20
    Sequence number: 0x80000003, Checksum: 0x76e5, LSA age: 42
    Interface: ifl-0/0/0/1, Neighbor address: 25.0.1.2
    Length: 0, Options: *|-|-|-|-|-|-|*
```

```
  LSA ID: 12.0.0.0
    Advertised router: 198.51.100.20, LSA type: Summary-Network, Router ID: 192.168.0.20
    Sequence number: 0x80000003, Checksum: 0x603d, LSA age: 42
    Interface: ifl-0/0/0/1, Neighbor address: 25.0.1.2
    Length: 0, Options: *|-|-|-|-|-|-|*
  LSA ID: 12.1.0.0
    Advertised router: 198.51.100.20, LSA type: Summary-Network, Router ID: 192.168.0.20
    Sequence number: 0x80000003, Checksum: 0x481f, LSA age: 42
    Interface: ifl-0/0/0/1, Neighbor address: 25.0.1.2
    Length: 0, Options: *|-|-|-|-|-|-|*
  LSA ID: 12.2.0.0
    Advertised router: 198.51.100.20, LSA type: Summary-Network, Router ID: 192.168.0.20
    Sequence number: 0x80000003, Checksum: 0x4aab, LSA age: 42
    Interface: ifl-0/0/0/1, Neighbor address: 25.0.1.2
    Length: 0, Options: *|-|-|-|-|-|-|*

 <...>
```

OSPF Transmission List

Displays the list of all LSAs waiting to be re-sent or transmitted from the router.

Syntax:

show ospf transmit-list <option>

Option	Description
-	Without any option, this command displays the transmit list of all link-state advertisements (LSA).
area <area-id>	OSPF transmit-list information for the given area.
instance <instance-name>	OSPF transmit-list information for the given instance.
<afi>	Displays transmit-list information for the specified address family. Supported AFI values are 'ipv4' and 'ipv6'.

Example: OSPF LSA requests waiting to be transmitted.

```
supervisor@rtbrick>SPINE01: op> show ospf transmit-list
Instance: default, Area: 0.0.0.1, Interface: ifl-0/0/4/1, Neighbor: 25.0.1.5
  LSA ID                  LS type                 Advertising router        Transmit interval
Retransmit count
  11.0.0.0                Summary-Network         198.51.100.20             5000                    1
  12.0.0.0                Summary-Network         198.51.100.20             5000                    1
  23.0.0.0                Summary-Network         198.51.100.20             5000                    1
  12.1.0.0                Summary-Network         198.51.100.20             5000                    1
  23.1.0.0                Summary-Network         198.51.100.20             5000                    1
  12.2.0.0                Summary-Network         198.51.100.20             5000                    1
  12.3.0.0                Summary-Network         198.51.100.20             5000                    1
```

OSPF Statistics

Displays OSPF statistics information.

Syntax:

show ospf statistics <options>

Option	Description
interface <interface-name>	Displays packet statistics information for the specified interface.
interface <interface-name> detail	Displays detailed packet statistics information for the specified interface.
neighbor <Neighbor-address>	Displays packet statistics information for the specified neighbor.
neighbor <Neighbor-address> <detail>	Displays detailed packet statistics information for the specified neighbor.
<afi>	Displays packet statistics information for the specified address family. Supported AFI values are 'ipv4' and 'ipv6'.

```
supervisor@rtbrick>SPINE01: op> show ospf statistics interface ifl-0/0/0/1 detail
Instance: default, Address family: ipv4
  Interface: ifl-0/0/0/1, Peer address: 12.0.0.2
    Hello packet:
      Received packets: 658, Sent packets: 659, Total errors: 0, Unsupported option: 0
      Area mismatch: 0, Area type option mismatch: 0, Dead interval mismatch: 0
      Hello interval mismatch: 0, Mask mismatch: 0, Self router ID: 0
      Obj add fail: 0, Source address mismatch: , Misc: 0
    DD packet:
      Received packets: 3, Sent packets: 4, Total errors: 1, Unsupported option: 0
      Invalid state packet rcvd: 0, MTU mismatch: 0, DD obj add fail: 0, Misc: 0, Negotiation fail: 0
      Master bit mismatch: 0, Exchange state init pkt: 0, Capabilities mismatch: 0
      Expected seq mismatch: 0, Full state init pkt: 0, Invalid lsa: 0, Invalid external lsa: 0,
      Lsdb Absent: 0, Lsa lookup fail: 0, Ls req add fail: 0
    LS request packet:
      Received packets: 0, Sent packets: 0, Total errors: 0, Invalid LSA type: 0
      Invalid state packet rcvd: 0, LSA lookup error: 0, LSA lookup fail: 0
      LSA obj add fail: 0, Misc: 0
    LS update packet:
      Received packets: 0, Sent packets: 0, Total errors: 0, Invalid LSA type: 0
      Zero length LSA: 0, LSA length exceeded: 0, LSA checksum fail: 0
      Invalid state packet rcvd: 0, LSA obj add fail: 0, Invalid LSA payload: 0, Misc: 0
    Ls ack packet:
      Received packets: 0, Sent packets: 0, Total errors: 0, LSA obj add fail: 0
      Invalid state packet rcvd: 0, Misc: 0
    Sanity errors:
      Payload max len error: 0, Payload min len error: 0, Invalid version: 0
      Invalid auth data len: 0, Auth data missing: 0, Invalid packet min len: 0
```

```
      Invalid area ID: 0, Invalid network mask: 0, Authentication fail: 1
Instance: default, Address family: ipv6, Instance ID: 0
  Interface: ifl-0/0/0/1, Peer address: fe80::7845:9aff:fec0:0
    Hello packet:
      Received packets: 658, Sent packets: 658, Total errors: 0, Unsupported option: 0
      Area mismatch: 0, Area type option mismatch: 0, Dead interval mismatch: 0
      Hello interval mismatch: 0, Mask mismatch: 0, Self router ID: 0
      Obj add fail: 0, Source address mismatch: , Misc: 0
    DD packet:
      Received packets: 4, Sent packets: 4, Total errors: 1, Unsupported option: 0
      Invalid state packet rcvd: 0, MTU mismatch: 0, DD obj add fail: 0, Misc: 0, Negotiation fail: 0
      Master bit mismatch: 0, Exchange state init pkt: 0, Capabilities mismatch: 0
      Expected seq mismatch: 0, Full state init pkt: 0, Invalid lsa: 0, Invalid external lsa: 0,
      Lsdb Absent: 0, Lsa lookup fail: 0, Ls req add fail: 0
    LS request packet:
      Received packets: 1, Sent packets: 1, Total errors: 0, Invalid LSA type: 0
      Invalid state packet rcvd: 0, LSA lookup error: 0, LSA lookup fail: 0
      LSA obj add fail: 0, Misc: 0
    LS update packet:
      Received packets: 4, Sent packets: 5, Total errors: 0, Invalid LSA type: 0
      Zero length LSA: 0, LSA length exceeded: 0, LSA checksum fail: 0
      Invalid state packet rcvd: 0, LSA obj add fail: 0, Invalid LSA payload: 0, Misc: 0
    Ls ack packet:
      Received packets: 4, Sent packets: 4, Total errors: 0, LSA obj add fail: 0
      Invalid state packet rcvd: 0, Misc: 0
    Sanity errors:
      Payload max len error: 0, Payload min len error: 0, Invalid version: 0
      Invalid auth data len: 0, Auth data missing: 0, Invalid packet min len: 0
      Invalid area ID: 0, Invalid network mask: 0, Authentication fail: 1
```

OSPF Clear Commands

Clear OSPF Neighbor

Clear OSPF neighbor state information.

Syntax:

clear ospf neighbor <options>

Option	Description
-	Without any option, the command clears all the OSPF neighbors.
instance <instance-name>	Clears OSPF neighbor information for the specified instance.
instance <instance-name> <afi>	Clears OSPF neighbor for the specified address family. Supported AFI values are 'ipv4' and 'ipv6'. Supported AFI values are 'ipv4' and 'ipv6'. When using an IPv6 address family with OSPFv3, an instance ID ranging from 0 to 31 must be specified.

Option	Description
instance <instance-name> <afi> area <area-id>	Clears OSPF neighbor for the specified area of the specified instance and address family.
instance <instance-name> <afi> area <area-id> interface <interface-name>	Clears OSPF neighbor for the specified interface for the specified area and address family of the specified instance.
force	Forcefully clears all the OSPF neighbors. This may impact DR/BDR election.
force instance <instance-name>	Forcefully clears the neighbor for the specified instance.
force instance <instance-name> <afi>	Forcefully clears OSPF neighbor for the specified address family.
force instance <instance-name> <afi> area <area-id>	Forcefully clears OSPF neighbor for the specified area of the specified instance and address family.
force instance <instance-name> <afi> area <area-id> interface <interface-name>	Forcefully clears OSPF neighbor for a specific interface and area of the specified instance and address family.

Example:

```
supervisor@rtbrick>SPINE01: cfg> clear ospf neighbor instance default ipv6 instance-id 0 area 0 interface
ifl-0/0/0/1
Triggered clear neighbor successfully
```

API To access the Operational State API that corresponds to this CLI, click include::common:partial$operational_api_links.adoc[tag=clear_ospf_neighbor].

Clear OSPF Statistics

Clear the OSPF statistics for all instances or a specified instance.

Syntax:

clear ospf statistics <options>

Option	Description
-	Without any option, the command clears all the OSPF statistics.
instance <instance-name>	Clears OSPF statistics information for the specified instance.
instance <instance-name> <afi>	Clears OSPF statistics for the specified address family of the specified instance. Supported AFI values are 'ipv4' and 'ipv6'. When using an IPv6 address family with OSPFv3, an instance ID ranging from 0 to 31 must be specified.
instance <instance-name> <afi> area <area-id>	Clears OSPF statistics for the specified area of the specified instance and address family.
instance <instance-name> <afi> area <area-id> interface <interface-name>	Clears OSPF statistics for the specified interface for the specified area of the specified instance and address family.

Example:

```
supervisor@rtbrick>SPINE01: cfg> clear ospf statistics instance default ipv6 instance-id 0 area 0.0.0.0
interface ifl-0/0/0/1
Cleared statistics for all ipv6 neighbors under Instance [default] Area [0.0.0.0] Interface [ifl-0/0/0/1]
```

Clear OSPF Database

Clear the OSPF database for all instances.

Syntax:

clear ospf database <options>

Option	Description
-	Without any option, the command clears all the OSPF database information.

Option	Description
<afi>	Clears OSPF database for the specified address family. Supported AFI values are 'ipv4' and 'ipv6'. Supported AFI values are 'ipv4' and 'ipv6'. When using an IPv6 address family with OSPFv3, an instance ID ranging from 0 to 31 must be specified.
<afi> instance <instance-name>	Clears OSPF database for the specified area of the specified instance and address family.

Example:

```
supervisor@rtbrick>SPINE01: cfg> clear ospf database ipv6 instance default instance-id 0
Triggered clear database successfully
```

2.8. LDP

2.8.1. LDP Overview

Label distribution protocol (LDP) is the most commonly used protocol in the MPLS network. It generates and distributes labels and thus helps in MPLS packet switching and forwarding. By using LDP, label-switching routers in an MPLS network can exchange label mapping information to create label-switched paths (LSPs) for switching data packets. RtBrick FullStack (RBFS) supports Dual-stack, which means LDP can exchange FEC-label bindings over either IPv4 or IPv6 networks.

Peer Discovery

LDP sends UDP multicast hello packets to discover its neighbors and establishes neighbor adjacency with other directly connected label switch routers (LSRs). The hello message is periodically sent on LDP-enabled interfaces.

Session Establishment

After peer discovery, “initialization messages” are sent to each other. In these messages, the session Parameters are sent to each other. The LDP sessions are maintained by periodic keep-alive message.

After the LDP neighbors are discovered, the TCP session is established and the LDP

FSM is triggered, and LDP session becomes operational. LSRs start exchanging label mapping information with each other.

Dual-stack LDP

By default, RBFS is dual-stack capable, which means it can exchange IPv4/IPv6 FEC bindings over IPv4/IPv6 media (LDP over IPv4/IPv6).

To enable or disable a particular address family in RBFS, use "status <enable|disable>" CLI. For details, see LDP Address Family Configuration.

When LDP is enabled on an interface that supports both IPv4 and IPv6, LDP will start exchanging IPv4 hellos. To send an IPv6 hello, the source IPv6 address must be configured. For details about configuring the source address, see LDP Instance Configuration.

By default, both IPv4 and IPv6 hello will use the same transport preference as IPv6, but this can be changed by using the "connection-preference <ipv4|ipv6>" CLI. For details, see LDP Instance Configuration.

The following points should be noted regarding this functionality:

Source address:

- The source address specifies the transport address, either IPv4 or IPv6, to be used by the LDP protocol.
- When the source address is not configured, only an IPv4 transport connection will be established. As a result, only IPv4 FECs will be installed. To install IPv6 FECs, the source IPv6 address needs to be configured.

Connection Preference:

- When LDP is configured for dual-stack operation, the transport connection preference is IPv6 by default, and LDP will establish TCP connections over IPv6. To establish an IPv4 LDP session, the connection preference must be set to IPv4, and LDP will distribute IPv4 and IPv6 FECs over IPv4 connections.

Targeted Label Distribution Protocol (T-LDP)

RBFS supports Targeted Label Distribution Protocol (T-LDP) that enables a router to establish an LDP session with a router that is not directly connected. T-LDP is

commonly used in MPLS networks to facilitate the distribution of labels across various segments of the network.

Label Generation

LDP generates label bindings for the IP addresses of the LDP-enabled loopback interfaces and then advertises them to all neighbors.

Label Management Modes

Label Advertisement Mode

LDP supports the Downstream Unsolicited feature in RBFS, where label bindings are advertised to all upstream neighbors. By default, label advertisement operates in the Downstream Unsolicited mode.

Label Distribution Control Mode

LDP supports the Ordered Label Distribution Control, where an LSR will initiate the transmission of the label mapping only for the prefix for which it has a label mapping from the next hop of the prefix or for which it is an egress.

Label Retention Mode

LDP supports the Liberal Label Retention Mode where all the label mapping advertisements for all routes received from all the LDP neighbors are retained.

Supported LDP Standards

RFC Number	Description
RFC 5036	LDP Specification The following modes are supported by RBFS for the features listed in RFC 5036: • Label advertisement: Downstream Unsolicited mode is supported but not Downstream on Demand mode. • Label distribution control: Ordered mode is supported, but not Independent mode. • Label retention: Liberal mode is supported, but not Conservative mode.
RFC 5283	LDP Extension for Inter-Area Label Switched Paths (LSPs)
RFC 5443	LDP IGP Synchronization
RFC 7552	IPv6 Dual-Stack



RFC and draft compliance are partial except as specified.

Supported LDP Features

The following LDP features are supported in this release of RBFS:

- Support for the following label management modes.

  Downstream unsolicited mode in label advertisement

  Ordered mode in the label distribution control

  Liberal mode in label retention
- Loop detection
- Targeted Label Distribution Protocol (T-LDP)
- Inter-area support
- Tracking IGP metric
- IGP LDP synchronization
- LDP Dual-stack support
- LDP TCP authentication

- LDP redistribution
- LDP policy configuration

Supported Platforms

Not all features are necessarily supported on each hardware platform. Refer to the *Platform Guide* for the features and the sub-features that are or are not supported by each platform.

2.8.2. LDP Configuration

LDP Configuration Hierarchy

The diagram below illustrates the LDP configuration hierarchy.

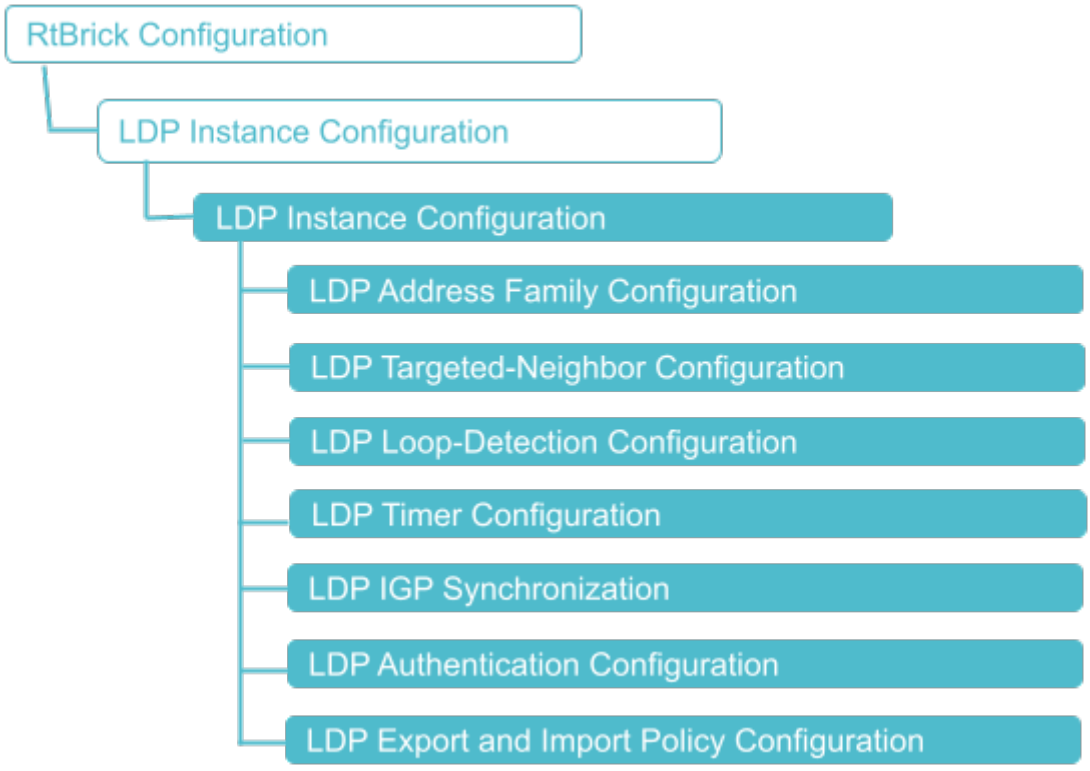


Figure 18. LDP Configuration Hierarchy

Configuration Syntax and Commands

The following sections describe the LDP configuration syntax and commands.

LDP Instance Configuration

At this configuration hierarchy, you configure LDP protocol parameters which are generic to the LDP instance.

Syntax:

set instance <instance-name> **protocol ldp** <attribute> <value>

Attribute	Description
<instance-name>	Name of the LDP instance.
interface <name>	Name of the logical interface.
router-id <router-id>	Router identifier in IPv4 format.
address-family <afi>	Address family identifier (AFI). Supported values: ipv4, or ipv6. Refer to section LDP Address Family Configuration for LDP address family configuration details.
connection-preference <afi>	Specifies the connection preference for the TCP session. Supported values: ipv4, or ipv6. By default, IPv6 is used as the preferred TCP connection if an IPv6 source address is configured. Refer to section Dual-stack LDP for more information on the LDP Dual-stack behaviour.
igp-synchronization <...>	LDP IGP synchronization configuration. This option is supported only on interfaces running Intermediate System-to-System (IS-IS) or OSPFv2 processes. Refer to section LDP IGP Synchronization for LDP-IGP synchronization configuration details.
source-address <ipv4|ipv6> <source-address>	Use the specified IP addresses (IPv4 or IPv6) as the transport address for the LDP session. For LDP over IPv6, the IPv6 source address is mandatory. Refer to section Dual-stack LDP for more information on the LDP Dual-stack behavior.

Attribute	Description
loop-detection <...>	The LDP loop detection feature enables LDP to detect loops during an LSP establishment. Refer to section LDP Loop Detection Configuration for the loop detection configuration details.
protocol-preference (internal | external) <preference-value>	Specifies the protocol preference of routes learned by T-LDP ('external'), LDP ('internal'), or both. This preference is used to select routes learned from multiple protocols. external: Range: 1 to 255. Default: 190. internal: Range: 1 to 255. Default: 9.
timer <...>	Specifies the Hello hold time, Hello interval, Keepalive hold time, and Keepalive interval. Refer to section LDP Timer Configuration for the LDP timer configuration details.
session <ipv4|ipv6> <address> `authentication-id <...>	Specifies an IPv4 or IPv6 LDP session attributes to apply TCP authentication. Refer to section LDP Authentication Configuration.
targeted-neighbor <ipv4|ipv6> <neighbor-address> <source-address>	Specifies the IPv4 or IPv6 address of the targeted LDP neighbor. Refer to section LDP Targeted Neighbor Configuration.
session <ipv4|ipv6> <address> export-policy|import-policy <...>	Specifies an IPv4 or IPv6 LDP session attributes to apply import/export policy configurations. Refer to section LDP Import and Export Policy Configuration.

Example: LDP Instance Configuration

This following configuration example sets the LDP router ID and enables LDP on various interfaces for the default instance.

```
set instance default protocol ldp router-id 198.51.100.1
set instance default protocol ldp interface ifl-0/0/0/1
set instance default protocol ldp interface ifl-0/0/0/100
set instance default protocol ldp interface ifl-0/0/0/101
set instance default protocol ldp interface ifl-0/0/1/102
set instance default protocol ldp interface ifl-0/0/2/1
set instance default protocol ldp interface ifl-0/0/3/1
set instance default protocol ldp interface lo-0/0/0/1
```

```
set instance default protocol ldp interface lo-0/0/0/2
set instance default protocol ldp interface lo-0/0/0/3
set instance default protocol ldp interface lo-0/0/0/4
set instance default protocol ldp interface lo-0/0/0/5
commit
```

```
supervisor@rtbrick>SPINE01: cfg> show config instance default protocol ldp
{
    "rtbrick-config:ldp": {
      "router-id": "198.51.100.1",
      "interface": [
        {
          "name": "ifl-0/0/0/1"
        },
        {
          "name": "ifl-0/0/0/100"
        },
        {
          "name": "ifl-0/0/0/101"
        },
        {
          "name": "ifl-0/0/1/102"
        },
        {
          "name": "ifl-0/0/2/1"
        },
        {
          "name": "ifl-0/0/3/1"
        },
        {
          "name": "lo-0/0/0/1"
        },
        {
          "name": "lo-0/0/0/2"
        },
        {
          "name": "lo-0/0/0/3"
        },
        {
          "name": "lo-0/0/0/4"
        },
        {
          "name": "lo-0/0/0/5"
        }
      ]
    }
  }
```

The following configuration example sets the administrative preference values for external and internal LDP routes within the default instance.

```
set instance default protocol ldp protocol-preference external 150
set instance default protocol ldp protocol-preference internal 8
commit
```

```
supervisor@rtbrick>LEAF01: cfg> show config instance default protocol ldp
protocol-preference
{
  "rtbrick-config:protocol-preference": {
    "external": 150,
    "internal": 8
  }
}
```

API To access the RESTCONF API that corresponds to this CLI, click here.

LDP Targeted Neighbor Configuration

The targeted neighbor configuration establishes an LDP neighbor with a remote neighbor that is not directly connected.

Syntax:

set instance <instance> **protocol ldp targeted-neighbor** <attribute> <value>

Attribute	Description
ipv4 <neighbor-address>	IPv4 address of the remote LDP neighbor.
ipv4 <neighbor-address> <source-address>	Neighbhor address to which ldp hello is sent
ipv4 <neighbor-address> <source-address> hold-time <hold-time>	Targeted hold time, <0-65535>, default 45s
ipv4 <neighbor-address> <source-address> interval <interval>	Targeted hello messages interval, <0-65535>, default 15s
ipv4 <neighbor-address> <source-address> neighbor-type <receiver |sender>	Specifies the neighbor type, that is, sender or receiver.
ipv6 <neighbor-address>	IPv6 address of the remote LDP neighbor.
ipv6 <neighbor-address> <source-address>	Neighbhor address to which ldp hello is sent

Attribute	Description
ipv6 <neighbor-address> <source-address> hold-time <hold-time>	Targeted hold time, <0-65535>, default 45s
ipv6 <neighbor-address> <source-address> interval <interval>	Targeted hello messages interval, <0-65535>, default 15s
ipv6 <neighbor-address> <source-address> neighbor-type <receiver |sender>	Specifies the neighbor type, that is, sender or receiver.

The following example configurates the targeted LDP neighbors for both IPv4 and IPv6 addresses within the default instance.

```
set instance default protocol ldp targeted-neighbor ipv4 neighbor-address
198.51.100.1 source-address 198.51.100.2
set instance default protocol ldp targeted-neighbor ipv4 neighbor-address
198.51.100.5 source-address 198.51.100.2
set instance default protocol ldp targeted-neighbor ipv6 neighbor-address
2001:DB8::1 source-address 2001:DB8::2
set instance default protocol ldp targeted-neighbor ipv6 neighbor-address
2001:DB8::5 source-address 2001:DB8::2
```

```
supervisor@rtbrick>SPINE01: cfg> show config instance default protocol ldp
targeted-neighbor
{
  "rtbrick-config:targeted-neighbor": {
    "ipv4": [
      {
        "neighbor-address": "198.51.100.1",
        "source-address": "198.51.100.2"
      },
      {
        "neighbor-address": "198.51.100.5",
        "source-address": "198.51.100.2"
      }
    ],
    "ipv6": [
      {
        "neighbor-address": "2001:DB8::1",
        "source-address": "2001:DB8::2"
      },
      {
        "neighbor-address": "2001:DB8::5",
        "source-address": "2001:DB8::2"
      }
    ]
  }
```

```
}
```

To access the RESTCONF API that corresponds to this CLI, click here.

LDP Address Family Configuration

The address-family command allows you to enable the address families that LDP will route and configure settings that are specific to that address family.

Syntax:

set instance <instance-name> **protocol ldp address-family** <attribute> <value>

Attribute	Description
<afi>	Address family identifier (AFI). Supported AFI values: ipv4, ipv6.
<safi>	Subsequent address family identifier (SAFI). Supported SAFI value: labeled-unicast. Configuring SAFI is now mandatory during the redistribution configuration or when enabling/disabling status.
<afi> <safi> status <enable|disable>	Enable or disable address family. By default, both IPv4 and IPv6 address families are enabled, as LDP supports dual stack. Refer to section Dual-stack LDP for more information on the LDP Dual-stack behavior.
<afi> <safi> redistribute <source>	Specifies the source from which the routes are to be redistributed. The available options include direct, ipoe, isis, ospf, ppp, and static.
<afi> <safi> redistribute <source> policy <policy>	Specifies the name of the policy map. The redistribute attach point allows routes from other sources to be advertised by LDP. The policy can be applied only to the routes that are redistributed from other sources to LDP.

Example 1: LDP Address Family Configuration

```
set instance default protocol ldp address-family ipv6 labeled-unicast status
enable
commit
```

```
supervisor@rtbrick>SPINE01: cfg> show config instance default protocol ldp
address-family
{
  "rtbrick-config:address-family": [
    {
      "afi": "ipv6",
      "safi": "labeled-unicast",
      "status": "enable"
    }
  ]
}
```

Example 2: LDP Redistribution Configuration

```
set instance default protocol ldp address-family ipv4 redistribute direct
commit
```

```
supervisor@rtbrick>SPINE01: cfg> show config instance default protocol ldp
address-family ipv4 redistribute direct
{
  "rtbrick-config:redistribute": [
    {
      "source": "direct"
    }
  ]
}
```

Example 3: LDP Policy Configuration

```
set instance default protocol ldp address-family ipv4 redistribute direct policy
filter-link-address
commit
```

```
supervisor@rtbrick>SPINE01: cfg> show config instance default protocol ldp
address-family ipv4 redistribute
{
  "rtbrick-config:redistribute": [
    {
      "source": "direct",
      "policy": "filter-link-address"
    }
  ]
}
```

To access the RESTCONF API that corresponds to this CLI, click here.

LDP Loop Detection Configuration

The LDP loop detection feature enables LDP to detect loops during an LSP establishment.

Syntax:

set instance <instance-name> **protocol ldp loop-detection** <attribute> <value>

Attribute	Description
hop-count <hop-count>	Specifies the hop count limit for loop detection. Range: 0-255. Default: 32.
status <enable|disable>	Enables or disables loop detection. By default, this option is disabled. When this option is enabled, both hop count and path vector are enabled.
vector-length <vector-length>	Specifies the path vector length limit for loop detection. Range: 0-255. Default: 32.

Example 1: LDP Loop Detection Configuration

```
set instance default protocol ldp loop-detection enable true
set instance default protocol ldp loop-detection hop-count 64
set instance default protocol ldp loop-detection vector-length 64
commit
```

```
supervisor@rtbrick>SPINE01: cfg> show config instance default protocol ldp loop-
detection
{
    "rtbrick-config:loop-detection": {
      "enable": "true",
      "hop-count": 64,
      "vector-length": 64
    }
  }
```

To access the RESTCONF API that corresponds to this CLI, click here.

LDP Timer Configuration

Specify the hello timer and hold-down timer for LDP adjacency. Similarly, specify the keepalive and keepalive timeout settings for the LDP session.

Syntax:

set instance <instance-name> **protocol ldp timer** <attribute> <value>

Attribute	Description
hello hold-time <hold-time>	Specifies the hello hold-time interval in seconds before declaring a neighbor to be down. Range: 0-65535. Default: 15.
hello interval <interval>	Specifies the hello messages interval in seconds. Range: 0-65535. Default: 5.
session keepalive-interval <keepalive-interval>	Specifies the session keepalive messages interval in seconds. Range: 1-65535. Default: 10.
session keepalive-timeout <keepalive-timeout>	Specifies the session keepalive timeout in seconds before declaring a session to be down. Range: 1-65535. Default: 30.

Example 1: LDP Timer Configuration

```
set instance default protocol ldp timer hello interval 10
set instance default protocol ldp timer hello hold-time 20
set instance default protocol ldp timer session keepalive-interval 3000
set instance default protocol ldp timer session keepalive-timeout 5000
commit
```

```
supervisor@rtbrick>SPINE01: cfg> show config instance default protocol ldp timer
{
    "rtbrick-config:timer": {
      "hello": {
        "interval": 10,
        "hold-time": 20
      },
      "session": {
        "keepalive-interval": 3000,
        "keepalive-timeout": 5000
      }
    }
  }
```

To access the RESTCONF API that corresponds to this CLI, click here.

LDP IGP Synchronization

Synchronization between LDP and the underlying interior gateway protocol (IGP) ensures that the LDP path is fully established before the IGP path is used for forwarding traffic. LDP IGP synchronization is supported only on interfaces running Intermediate System-to-System (IS-IS) or OSPFv2 processes.

Syntax:

set instance <instance-name> **protocol ldp igp-synchronization** <attribute> <value>

Attribute	Description
hold-timer <hold-timer>	Specifies the hold-timer in seconds to limit how long the IGP session must wait before declaring the LDP synchronization. Range: 0-60. Default: 10.

Example 1: LDP IGP Synchronization Configuration

```
set instance default protocol ldp igp-synchronization hold-timer 60
commit
```

```
supervisor@rtbrick>SPINE01: cfg> show config instance default protocol ldp igp-
synchronization
{
    "rtbrick-config:igp-synchronization": {
     hold-timer": 60,
    }
  }
```

To access the RESTCONF API that corresponds to this CLI, click here.

LDP Authentication Configuration

To meet the security requirements of LDP sessions, configure LDP authentication.

Syntax:

set instance <instance-name> **protocol ldp session ipv4|ipv6** <address> **authentication-id** <authentication-id>

Attribute	Description
<address>	Specifies the transport IP address of the peer.
<authentication-id>	Authentication Tuple Identifier

Example 1: LDP Authentication Configuration

```
set instance default protocol ldp session ipv4 address 198.51.100.2
authentication-id auth_id_1
commit
```

```
supervisor@rtbrick>SPINE01: cfg> show config instance default protocol ldp session
ipv4
{
  "rtbrick-config:ipv4": [
    {
      "address": "198.51.100.2",
      "authentication-id": "auth_id_1"
    }
  ]
}
```

API To access the RESTCONF API that corresponds to this CLI, click here.

TCP Authentication Configuration

In the instance TCP authentication hierarchy, you can optionally enable MD5 or HMAC-SHA-1-96, HMAC-SHA-256-128, or AES-128-CMAC-96 authentication. Authentication is not configured for LDP directly, but for the TCP sessions used by LDP.

Syntax:

set instance <instance> **tcp authentication** <authentication-id> <attribute> <value>

Attribute	Description
<authentication-id>	Authentication identifier
type <type>	Authentication identifier such as MD5 or HMAC-SHA-1-96,HMAC-SHA-256-128 or AES-128-CMAC-96
key1-id <key1-id>	Key ID1 of the receiver
key1-encrypted-text <key1-encrypted-text>	Encrypted text of key1
key1-plain-text <key1-plain-text>	Plain text of key1
key2-id <key2-id>	Key ID2 of the receiver
key2-encrypted-text <key2-encrypted-text>	Encrypted text of key2
key2-plain-text <key2-plain-text>	Plain text of key2

Example: LDP TCP Authentication Configuration

```
set instance default tcp authentication auth_id_1 type MD5
set instance default tcp authentication auth_id_1 key1-id 1
set instance default tcp authentication auth_id_1 key1-encrypted-text
"$2a6fd7db50a18a9f1f16b5c5b4214fab0"
commit
```

```
supervisor@rtbrick>SPINE01: cfg> show config instance default tcp authentication
auth_id_1
{
  "rtbrick-config:authentication": [
    {
      "authentication-id": "auth_id_1",
      "type": "MD5",
      "key1-id": 1,
      "key1-encrypted-text": "$2a6fd7db50a18a9f1f16b5c5b4214fab0"
    }
  ]
}
```

API To access the RESTCONF API that corresponds to this CLI, click here.

LDP Import and Export Policy Configuration

Syntax:

set instance <instance-name> **protocol ldp session ipv4|ipv6** <address> <attribute> <value>

Attribute	Description
<address>	Specifies the IPv4 or IPv6 address.
export-policy <export-policy>	Export policy identifier
import-policy <import-policy>	Import policy identifier

Example 1: LDP Export Configuration

```
set instance default protocol ldp session ipv4 address 198.51.100.2 export-policy
exp-policy1
commit
```

```
supervisor@rtbrick>SPINE01: cfg> show config instance default protocol ldp session
ipv4
{
  "rtbrick-config:ipv4": [
    {
      "address": "198.51.100.2",
      "export-policy": "exp-policy1"
    }
  ]
}
```

Example 3: LDP Import Configuration

```
set instance default protocol ldp session ipv4 address 198.51.100.2 import-policy
imp-policy1
commit
```

```
supervisor@rtbrick>SPINE01: cfg> show config instance default protocol ldp session
ipv4
{
  "rtbrick-config:ipv4": [
    {
      "address": "198.51.100.2",
      "import-policy": "imp-policy1"
    }
  ]
}
```

To access the RESTCONF API that corresponds to this CLI, click here.

2.8.3. LDP Operational Commands

LDP Show Commands

The LDP show commands provide detailed information about the LDP protocol operations.

LDP Summary

Syntax:

show ldp summary <options>

Option	Description
-	Without any option, the command displays the LDP summary information for all instances.
instance <instance-name>	Displays LDP summary information about the specified instance.

Example: LDP summary for the default instance

```
supervisor@rtbrick>SPINE01: op> show ldp summary
Instance: default
  General information:
    LDP identifier: 198.51.100.2:0, Version: 1
    FEC resolution: Best match
    Protocol preference: 9
    LSR ID: 198.51.100.2
    IPv4 Status: True
    IPv6 Status: True
  Modes:
    Advertisement mode: Downstream Unsolicited
    Advertisement control mode: Ordered
    Label retention mode: Liberal
  Capabilities:
    IPv6 address family: -  , Graceful restart: False
    Loop detection: False
      Hop count: -, Vector length: -
  Timers:
    Adjacency:
      Hello: 5s, Holdtime: 15s
    Targeted adjacency:
      Hello: 15s, Holdtime: 45s
    Session:
```

```
      Keepalive: 10s, Holdtime: 30s
  Statistics:
    Adjacency:
      Link adjacency: 2, Targeted adjacency: 0
    Session:
      Session in non-existent: 0, Session in initialized: 0
      Session in opensent: 0, Session in openconfirm: 0
      Session in operational: 2
Instance: green
  General information:
    LDP identifier: 192.0.2.2:0, Version: 1
    FEC resolution: Best match
    Protocol preference: 9
    LSR ID: 192.0.2.2
    IPv4 Status: True
    IPv6 Status: True
  Modes:
    Advertisement mode: Downstream Unsolicited
    Advertisement control mode: Ordered
    Label retention mode: Liberal
  Capabilities:
    IPv6 address family: -  , Graceful restart: False
    Loop detection: False
      Hop count: -, Vector length: -
  Timers:
    Adjacency:
      Hello: 5s, Holdtime: 15s
    Targeted adjacency:
      Hello: 15s, Holdtime: 45s
    Session:
      Keepalive: 10s, Holdtime: 30s
<...>
```

API To access the Operational State API that corresponds to this CLI, click here.

LDP Neighbor

Syntax:

show ldp neighbor <options>

Option	Description
-	Without any option, this command displays information about LDP neighbors.
detail	Detailed information about the LDP neighbors.
instance <instance-name>	Displays LDP neighbor information about the specified instance.

Option	Description
instance <instance-name> detail	Displays detailed LDP neighbor information about the specified instance.
instance <instance-name> ldp-id <ldp-id>	Displays LDP neighbor information about the specified LDP identifier and instance.
interface <name>	Displays LDP neighbor information about the specified interface.
interface <name> detail	Displays detailed LDP neighbor information about the specified interface.
ldp-id <ldp-id>	Displays LDP neighbor information about the specified LDP identifier.

Example 1: Summary view of all the LDP neighbors

```
supervisor@rtbrick>SPINE01: op> show ldp neighbor
Instance: default
  Interface        LDP ID              Transport IP   Up Since
Expires
  ifl-0/0/0/1      198.51.100.2:0      198.51.100.2   Thu Feb 09 12:17:15       in
11s
  ifl-0/0/2/1      198.51.100.3:0      198.51.100.3   Thu Feb 09 12:17:31       in
12s
  ifl-0/0/0/100    198.51.100.2:0      198.51.100.2   Thu Feb 09 12:17:15       in
11s
  ifl-0/0/0/101    198.51.100.2:0      198.51.100.2   Thu Feb 09 12:17:15       in
11s
  ifl-0/0/1/102    198.51.100.2:0      198.51.100.2   Thu Feb 09 12:17:15       in
11s
supervisor@rtbrick>SPINE01: op>
```

Example 2: Detailed view of all the LDP neighbors

```
supervisor@rtbrick>SPINE01: op> show ldp neighbor detail
Instance: default
  LDP-Identifier: 198.51.100.1:0, Peer: 198.51.100.1, Type: Targeted
  Negotiated holdtime: 45000, Expiry time: 31s 880316us
  Local link address: 198.51.100.2, Peer link address: 198.51.100.1
  Local transport address: 198.51.100.2, Peer transport address: 198.51.100.1
  Local holdtime: 45, Peer holdtime: 45, Up since: Tue Mar 04 05:59:47
  Local transport preference : ipv6, Peer transport preference : ipv6
  Last transition time: Tue Mar 04 07:05:47 GMT +0000 2025
Instance: default
  LDP-Identifier: 198.51.100.5:0, Peer: 198.51.100.5, Type: Targeted
  Negotiated holdtime: 45000, Expiry time: 40s 850139us
  Local link address: 198.51.100.2, Peer link address: 198.51.100.5
  Local transport address: 198.51.100.2, Peer transport address: 198.51.100.5
  Local holdtime: 45, Peer holdtime: 45, Up since: Tue Mar 04 06:00:11
  Local transport preference : ipv6, Peer transport preference : ipv6
```

```
  Last transition time: Tue Mar 04 07:05:56 GMT +0000 2025
Instance: default
  LDP-Identifier: 198.51.100.1:0, Peer: 2001:DB8::1, Type: Targeted
  Negotiated holdtime: 45000, Expiry time: 31s 880318us
  Local link address: 2001:DB8::2, Peer link address: 2001:DB8::1
  Local transport address: 2001:DB8::2, Peer transport address: 2001:DB8::1
  Local holdtime: 45, Peer holdtime: 45, Up since: Tue Mar 04 05:59:47
  Local transport preference : ipv6, Peer transport preference : ipv6
  Last transition time: Tue Mar 04 07:05:47 GMT +0000 2025
<...>
```

Example 3: Summary view of all the targeted LDP neighbors

```
supervisor@rtbrick>SPINE01: op> show ldp neighbor
Instance: default
  Interface/Peer     LDP ID              Transport IP      Up Since
Expires
  198.51.100.1       198.51.100.1:0      198.51.100.1      Tue Mar 04 05:59:47
in 38s
  198.51.100.5       198.51.100.5:0      198.51.100.5      Tue Mar 04 06:00:11
in 32s
  2001:DB8::1        198.51.100.1:0      2001:DB8::1       Tue Mar 04 05:59:47
in 38s
  2001:DB8::5        198.51.100.5:0      2001:DB8::5       Tue Mar 04 05:59:56
in 32s
Instance: green
  Interface/Peer     LDP ID              Transport IP      Up Since
Expires
  192.0.2.1          192.0.2.1:0         192.0.2.1         Tue Mar 04 05:59:47
in 38s
  192.0.2.5          192.0.2.5:0         192.0.2.5         Tue Mar 04 06:00:11
in 32s
supervisor@rtbrick>SPINE01: op>
```

Example 4: Detailed view of a targeted LDP neighbor

```
supervisor@rtbrick>SPINE01: op> show ldp neighbor ldp-id 198.51.100.1:0
Instance: default
  LDP-Identifier: 198.51.100.1:0, Peer: 198.51.100.10, Type: Targeted
  Negotiated holdtime: 45000, Expiry time: 35s 775898us
  Local link address: 198.51.100.2, Peer link address: 198.51.100.1
  Local transport address: 198.51.100.2, Peer transport address: 198.51.100.1
  Local holdtime: 45, Peer holdtime: 45, Up since: Tue Mar 04 05:59:47
  Local transport preference : ipv6, Peer transport preference : ipv6
  Last transition time: Tue Mar 04 07:04:02 GMT +0000 2025
Instance: default
  LDP-Identifier: 198.51.100.1:0, Peer: 2001:DB8::1, Type: Targeted
  Negotiated holdtime: 45000, Expiry time: 35s 775923us
  Local link address: 2001:DB8::2, Peer link address: 2001:DB8::1
  Local transport address: 2001:DB8::2, Peer transport address: 2001:DB8::1
  Local holdtime: 45, Peer holdtime: 45, Up since: Tue Mar 04 05:59:47
  Local transport preference : ipv6, Peer transport preference : ipv6
  Last transition time: Tue Mar 04 07:04:02 GMT +0000 2025
supervisor@rtbrick>SPINE01: op>
```

LDP Interface

Syntax:

show ldp interface <option>

Option	Description
-	Without any option, this command displays information on all configured LDP interfaces.
<interface-name>	Specify the name of the interface.
detail	Detailed interface information.

Example 1: Summary view of the specified LDP interface

```
supervisor@rtbrick: cfg> show ldp interface ifl-0/0/1/1
Instance: green
  Interface: ifl-0/0/1/1
    Primary IPv4 Address: 192.0.2.102, Primary IPv6 Address: 2001:DB8:12::1
    Session Hold: 30, Session Keepalive: 10
    Discovery Hello: 5, Discovery Hold: 15
    Neighbor count: 1, Transport preference: ipv4
    IPv4 enable: True, IPv6 enable: True, Cisco interop: False
```

Example 2: Summary view of all the LDP interfaces

```
supervisor@rtbrick: cfg> show ldp interface
Instance: default
  Interface            Primary IPv4 Address      Primary IPv6 Address
  ifl-0/0/0/1          198.51.100.100            2001:DB8:1::1
  ifl-0/0/0/100        198.51.100.101            2001:DB8:2::1
  ifl-0/0/0/101        198.51.100.102            2001:DB8:3::1
  ifl-0/0/1/102        198.51.100.103            2001:DB8:4::1
  ifl-0/0/2/1          198.51.100.104            2001:DB8:5::1
  ifl-0/0/3/1          198.51.100.105            2001:DB8:6::1
  lo-0/0/0/1           198.51.100.1
  lo-0/0/0/2           198.51.100.2
  lo-0/0/0/3           198.51.100.3
  lo-0/0/0/4           198.51.100.4
  lo-0/0/0/5           198.51.100.5
Instance: green
  Interface            Primary IPv4 Address      Primary IPv6 Address
  ifl-0/0/0/202        192.0.2.100               2001:DB8:11::1
  ifl-0/0/1/1          192.0.2.102               2001:DB8:12::1
  ifl-0/0/1/200        192.0.2.103               2001:DB8:13::1
  ifl-0/0/1/201        192.0.2.104               2001:DB8:14::1
  ifl-0/0/2/200        192.0.2.105               2001:DB8:15::1
  ifl-0/0/3/200        192.0.2.105               2001:DB8:16::1
  lo-0/0/1/1           192.0.2.1
```

```
  lo-0/0/1/2          192.0.2.2
  lo-0/0/1/3          192.0.2.3
  lo-0/0/1/4          192.0.2.4
  lo-0/0/1/5          192.0.2.5
```

LDP Session

Syntax:

show ldp session <options>

Option	Description
-	Without any option, this command displays a summary of LDP session information.
detail	Displays detailed information about the LDP sessions.
instance <instance-name>	Displays LDP session information about the specified instance.
instance <instance-name> detail	Displays detailed LDP session information about the specified instance.
instance <instance-name> ldp-id <ldp-id>	Displays LDP session information about the specified LDP identifier and instance.
ldp-id <ldp-id>	Displays LDP session information about the specified LDP identifier.

Example 1: Summary view of the LDP session

```
supervisor@rtbrick>SPINE01: op> show ldp session
Instance: default
  LDP ID            Peer IP           State             Up/Down           FECRcvd   FECSent
  198.51.100.2:0    198.51.100.2       Operational       0d:00h:29m:44s         15        15
  198.51.100.3:0    198.51.100.3       Operational       0d:00h:29m:29s         15        15
supervisor@rtbrick>SPINE01: op>
```

Example 2: Detailed view of the LDP session

```
supervisor@rtbrick>SPINE01: op> show ldp session detail
Instance: default
  LDP Identifier: 198.51.100.2:0, Peer IP: 198.51.100.2, Local IP: 198.51.100.1
    Type: link, State: Operational, Uptime: 0d:00h:34m:35s
    Reason:
    Last transition: Thu Feb 09 12:17:28 GMT +0000 2023, Flap count: 0
```

```
  Advertisement Mode:
    Peer: Downstream unsolicited, Local: Downstream unsolicited
    Negotiated: Downstream unsolicited
  Timers:
    Connect retry: 10s
    Peer keepalive interval: 10s, Local keepalive interval: 10s
    Peer keepalive timeout: 30s, Local keepalive timeout: 30s
    Negotiated keepalive interval: 10s
    Negotiated keepalive timeout: 30s
  Received messages:
    Initialization: 1, KeepAlive: 208, Notification: 0
    Address: 1, Address Withdraw: 0, Label Mapping: 15
    Label Withdraw: 0, Label Release: 0
  Sent messages:
    Initialization: 1, KeepAlive: 208, Notification: 0
    Address: 1, Address Withdraw: 0, Label Mapping: 15
    Label Withdraw: 0, Label Release: 0
  Capability:
    Typed WildCard FEC:
    Local Support: True, Peer Support: True, Negotiated: True
  Total received messages:
    Initialization: 1, KeepAlive: 92, Notification: 0
    Address: 2, Address Withdraw: 0, Label Mapping: 20
  Total sent messages:
    Initialization: 1, KeepAlive: 92, Notification: 0
    Address: 2, Address Withdraw: 0, Label Mapping: 20
    Label Withdraw: 0, Label Release: 0
<...>
```



In the case of a T-LDP session, the "Type" will be "Targeted".



To access the Operational State API that corresponds to this CLI, click here.

LDP Address

Syntax:

show ldp address <options>

Option	Description
-	Without any option, this command displays a summary of all the interface addresses received from the LDP sessions.
instance <instance-name>	Displays LDP address information about the specified instance.
instance <instance-name> <afi>	Displays LDP address of the specified address family (AFI). Supported values: ipv4, ipv6.

Option	Description
instance <instance-name> ldp-id <ldp-id>	Displays LDP address information about the specified LDP identifier and instance.
ldp-id <ldp-id>	Displays LDP address information about the specified LDP identifier.

Example: Summary view of all the LDP addresses

```
supervisor@rtbrick>SPINE01: op> show ldp address
Instance: default, LDP Identifier: 198.51.100.2:0, AFI: ipv4
  198.51.100.61
  198.51.100.102
  198.51.100.63
  198.51.100.94
  198.51.100.2
  198.51.100.65
  198.51.100.222
  198.51.100.21
  198.51.100.214
  198.51.100.48
<...>
```

LDP Binding

Syntax:

show ldp binding <options>

Option	Description
-	Without any option, this command displays a summary of all the LDP label bindings.
detail	Displays detailed LDP label binding information.
instance <instance-name>	Displays LDP label binding information of the specified instance.
instance <instance-name> <afi>	Displays LDP label binding information of the specified address family. Supported AFI value: IPv4, IPv6.
instance <instance-name> <afi> detail	Displays detailed LDP label binding information of the specified address family.

Option	Description
instance <instance-name> <afi> prefix <ip>	Displays LDP label binding information of the specified prefix and instance for the specified address family.
instance <instance-name> <afi> prefix <ip> detail	Displays detailed LDP label binding information of the specified prefix and instance for the specified address family.
received	Displays the LDP received label binding information of the LDP sessions.
received instance <instance-name> <afi>	Displays LDP received label binding information of the specified address family and instance.
received instance <instance-name> <afi> detail	Displays detailed LDP received label binding information of the specified address family and instance.
received instance <instance-name> <afi> ldp-id <ldp-id>	Displays LDP received label binding information of the specified instance.
received instance <instance-name> <afi> ldp-id <ldp-id> detail	Displays detailed LDP received label binding information of the specified LDP identifier and instance.
received <afi>	Displays LDP received label binding information of the specified address family. Supported AFI values: IPv4, IPv6.
received <afi> detail	Displays detailed LDP received label binding information of the specified address family.
received <afi> instance <instance-name>	Displays LDP received label binding information of the specified address family and instance.
received <afi> instance <instance-name> detail	Displays detailed LDP received label binding information of the specified address family and instance.
received <afi> instance <instance-name> ldp-id <ldp-id>	Displays LDP received label binding information of the specified address family, instance, and LDP identifier.

Option	Description
received <afi> ldp-id <ldp-id>	Displays LDP received label binding information of the specified address family and LDP identifier.
received <afi> ldp-id <ldp-id> detail	Displays detailed LDP received label binding information of the specified address family and LDP identifier.
sent	Displays the LDP sent label binding information of the LDP sessions.
sent instance <instance-name> <afi>	Displays LDP sent label binding information of the specified address family and instance. Supported AFI values: IPv4, IPv6.
sent instance <instance-name> <afi> detail	Displays detailed LDP sent label binding information of the specified address family and instance.
sent instance <instance-name> <afi> prefix <ip>	Displays LDP sent label binding information of the specified address family, instance, and prefix.
sent instance <instance-name> <afi> prefix <ip> detail	Displays detailed LDP sent label binding information of the specified address family, instance, and prefix.
sent <afi>	Displays LDP sent label binding information of the specified address family. Supported AFI values: IPv4, IPv6.
sent <afi> detail	Displays detailed LDP sent label binding information of the specified address family.
sent <afi> instance <instance-name>	Displays LDP sent label binding information of the specified address family and instance.
sent <afi> instance <instance-name> detail	Displays detailed LDP sent label binding information of the specified address family and instance.
sent <afi> instance <instance-name> prefix <ip>	Displays LDP sent label binding information of the specified address family, instance, and prefix.
sent <afi> instance <instance-name> prefix <ip> detail	Displays detailed LDP sent label binding information of the specified address family, instance, and prefix.

Option	Description
sent <afi> prefix <ip>	Displays LDP sent label binding information of the specified address family and prefix.
sent <afi> prefix <ip> detail	Displays detailed LDP sent label binding information of the specified address family and prefix.

Example 1: Summary view of the LDP binding

```
supervisor@rtbrick>SPINE01: op> show ldp binding

Instance: default, AFI: ipv4
  Prefix                In Label           Out Label          LDP ID
Status
  198.51.100.1/24        -                  3                  -
Best
                         label:20066        -                  198.51.100.3:0
Non-best
                         label:20065        -                  198.51.100.2:0
Non-best
  198.51.100.11/24       -                  3                  -
Best
                         label:20066        -                  198.51.100.3:0
Non-best
                         label:20065        -                  198.51.100.2:0
Non-best
  198.51.100.41/24       -                  3                  -
Best
                         label:20066        -                  198.51.100.3:0
Non-best
                         label:20065        -                  198.51.100.2:0
Non-best
  198.51.100.44/24       -                  3                  -
Best
                         label:20066        -                  198.51.100.3:0
Non-best
                         label:20065        -                  198.51.100.2:0
Non-best
  198.51.100.47/24       -                  3                  -
Best
                         label:20066        -                  198.51.100.3:0
Non-best
                         label:20065        -                  198.51.100.2:0
Non-best
  198.51.100.2/24        label:3            label:20065        198.51.100.2:0
Best
                         label:20065        -                  198.51.100.3:0
Non-best
  198.51.100.21/24       label:3            label:20065        198.51.100.2:0
Best
                         label:20065        -                  198.51.100.3:0
Non-best
  198.51.100.42/24       label:3            label:20065        198.51.100.2:0
Best
                         label:20065        -                  198.51.100.3:0
Non-best
```

```
<...>
```

Example 2: Summary view of the LDP binding for the specified prefix

```
supervisor@rtbrick>SPINE01: op> show ldp binding prefix 198.51.100.2/24
Instance: default, AFI: ipv4
  Prefix                In Label           Out Label          LDP ID
Status
  198.51.100.2/24       label:3            label:20065        198.51.100.2:0
Best
                        label:20065        -                  198.51.100.3:0
Non-best
supervisor@rtbrick>SPINE01: op>
```

LDP Route

Syntax:

show ldp route <options>

Option	Description
-	Without any option, this command displays a summary of LDP route information.
instance <instance-name>	Displays LDP route information for the specified instance.
instance <instance-name> <afi>	Displays LDP route information for the specified address family and instance. Supported AFI values: ipv4, ipv6, and mpls.
instance <instance-name> ipv4 prefix <ip>	Displays LDP route information for the specified address family of IPv4 prefix and instance.
instance <instance-name> ipv6 prefix <ip>	Displays LDP route information for the specified address family of IPv6 prefix and instance.
instance <instance-name> prefix <ip>	Displays LDP route information for the specified prefix and instance.
instance <instance-name> label <label>	Displays LDP route information for the specified MPLS label and instance.
instance <instance-name> mpls	Displays LDP route information about MPLS labels.

Option	Description
instance <instance-name> mpls label <label>	Displays LDP route information for the specified MPLS label and instance.
label <label>	Displays LDP route information for the specified MPLS label.
ipv4	Displays LDP route information about the IPv4 address family.
ipv4 prefix <ip>	Displays LDP route IPv4 address family information for the specified prefix.
ipv6	Displays LDP route information about the IPv6 address family.
ipv6 prefix <ip>	Displays LDP route IPv6 address family information for the specified prefix.
mpls	Displays LDP route information about MPLS labels.
mpls label <label>	Displays LDP route information for the specified MPLS label.
prefix <ip>	Displays LDP route information for the specified prefix address.

Example: Summary view of the LDP route

```
supervisor@rtbrick>SPINE01: op> show ldp route
Instance: default, AFI: ipv4, SAFI: labeled-unicast
  Prefix               Advertised label  Received label    Next Hop
Interface           Metric
  198.51.100.1/24       3                 -                 -              -
-
  198.51.100.2/24       20065             -                 198.51.100.61
ifl-0/0/0/1      1000000
  198.51.100.3/24       20067             20067             198.51.100.61
ifl-0/0/0/1      2000001
  198.51.100.11/24       3                 -                 -              -
-
  198.51.100.21/24       20065             -                 198.51.100.61
ifl-0/0/0/1      1000000
  198.51.100.31/24       20067             20067             198.51.100.61
ifl-0/0/0/1      2000001
  198.51.100.41/24       3                 -                 -              -
-
  198.51.100.42/24       20065             -                 198.51.100.61
ifl-0/0/0/1      1000000
  198.51.100.43/24       20067             20067             198.51.100.61
ifl-0/0/0/1      2000001
  198.51.100.44/24       3                 -                 -              -
```

```
-
  198.51.100.45/24       20065             -                198.51.100.61
ifl-0/0/0/1      1000000
  198.51.100.46/24       20067             20067            198.51.100.61
ifl-0/0/0/1      2000001
  198.51.100.47/24       3                 -                -              -
-
  198.51.100.48/24       20065             -                198.51.100.61
ifl-0/0/0/1      1000000
  198.51.100.49/24       20067             20067            198.51.100.61
ifl-0/0/0/1      2000001
<...>
```

LDP Statistics

Syntax:

show ldp statistics <options>

Option	Description
-	Without any option, the command displays the LDP statistics for all instances.
instance <instance-name>	Displays LDP statistics information about the specified instance.
instance <instance-name> ldp-id <ldp-id>	Displays LDP statistics information about the specified LDP identifier and instance.

Example: Summary view of the LDP statistics

```
supervisor@rtbrick>SPINE01: op> show ldp statistics
Instance: default, LDP ID: 198.51.100.2:0
  Received messages:
    Initialization: 1, KeepAlive: 558, Notification: 0
    Address: 1, Address Withdraw: 0, Label Mapping: 15
    Label Withdraw: 0, Label Release: 0
  Sent messages:
    Initialization: 1, KeepAlive: 558, Notification: 0
    Address: 1, Address Withdraw: 0, Label Mapping: 15
    Label Withdraw: 0, Label Release: 0
Instance: default, LDP ID: 198.51.100.3:0
  Received messages:
    Initialization: 1, KeepAlive: 557, Notification: 0
    Address: 1, Address Withdraw: 0, Label Mapping: 15
    Label Withdraw: 0, Label Release: 0
  Sent messages:
    Initialization: 1, KeepAlive: 557, Notification: 0
    Address: 1, Address Withdraw: 0, Label Mapping: 15
    Label Withdraw: 0, Label Release: 0
```

```
supervisor@rtbrick>SPINE01: op>
```

LDP TCP connection

Syntax:

show ldp tcp connection <options>

Option	Description
-	Without any option, the command displays the TCP connections used by LDP for all instances.
detail	Detailed list view of the TCP connections.
detail instance <instance-name>	Detailed list view of the TCP connections of the specified instance.
instance <instance-name>	TCP connections summary of the specified instance.

Example: Summary view of the LDP TCP connections

```
supervisor@rtbrick>SPINE01: op> show ldp tcp connection
Instance       Local IP             Remote IP            Local port     Remote
port   State
default        198.51.100.1         198.51.100.2                646
64718   Established
default        198.51.100.1         198.51.100.3                646
64718   Established
```

LDP Clear Commands

Clear commands allow resetting operational states.

Clear LDP Session

Syntax:

clear ldp session <options>

Option	Description
all	Clears all the LDP sessions.
all soft-in	Sends route refresh to all neighbors to receive FEC bindings.
all soft-out	Re-advertises all the routes previously sent to the peers.
instance <instance-name> all	Clears all the LDP sessions for the specified instance.
instance <instance> all soft-in	Sends route refresh to all neighbors to receive FEC bindings for the specified instance.
instance <instance> all soft-out	Re-advertises all the routes previously sent to the peers for the specified instance.
instance <instance-name> peer ldp-id <ldp-id>	Clears the LDP session for the specified instance and peer LDP identifier.
instance <instance> peer ldp-id <ldp-id> soft-in	Sends route refresh to the specific peer to receive FEC bindings for the specified instance and peer ldp-id.
instance <instance> peer ldp-id <ldp-id> soft-out	Re-advertises all the routes previously sent to the specific peer for the specified instance and peer ldp-id.

Example: The example below shows how to clear all the LDP sessions.

```
supervisor@rtbrick>SPINE01: op> clear ldp session all
LDP session cleared with instance default
supervisor@rtbrick>SPINE01: op>
```

API To access the Operational State API that corresponds to this CLI, click here.

Clear LDP Statistics

Syntax:

clear ldp statistics <options>

Option	Description
all	Clears all the LDP statistics.
instance <instance-name> all	Clears all the LDP statistics for the specified instance.
instance <instance-name> peer ldp-id <ldp-id>	Clears the LDP statistics for the specified instance and peer LDP identifier.

Example: The example below shows how to clear all the LDP statistics.

```
supervisor@rtbrick>SPINE01: op> clear ldp statistics all
LDP statistics cleared for instance default
supervisor@rtbrick>SPINE01: op>
```

Clear LDP Neighbor

Syntax:

clear ldp neighbor <options>

Option	Description
all	Clears all the LDP neighbors.
instance <instance-name>	Clears the LDP neighbor for the specified instance.

Example: The example below shows how to clear all the LDP neighbor.

```
supervisor@rtbrick>SPINE01: op> clear ldp neighbor all
LDP neighbor cleared with instance default
supervisor@rtbrick>SPINE01: op>
```

2.9. Policy

2.9.1. Policy Overview

Policies are rules that allow to control and modify the behavior of routing protocols such as BGP, IS-IS, OSPF, and other supported protocols. The policy framework is generic; it serves multiple purposes and applications. Policies are first created using a common policy configuration and then applied by attaching

them to an application like a protocol.

The following diagram shows policy configuration options.



Figure 19. Policy Configuration Options

Policy Components

In RtBrick Full Stack, the policy implementation consists of 4 sub-components:

- Policy Repository
- Command Processing Module
- Policy Server, the policy generation and relationship management component
- Policy Client, the policy enforcement component

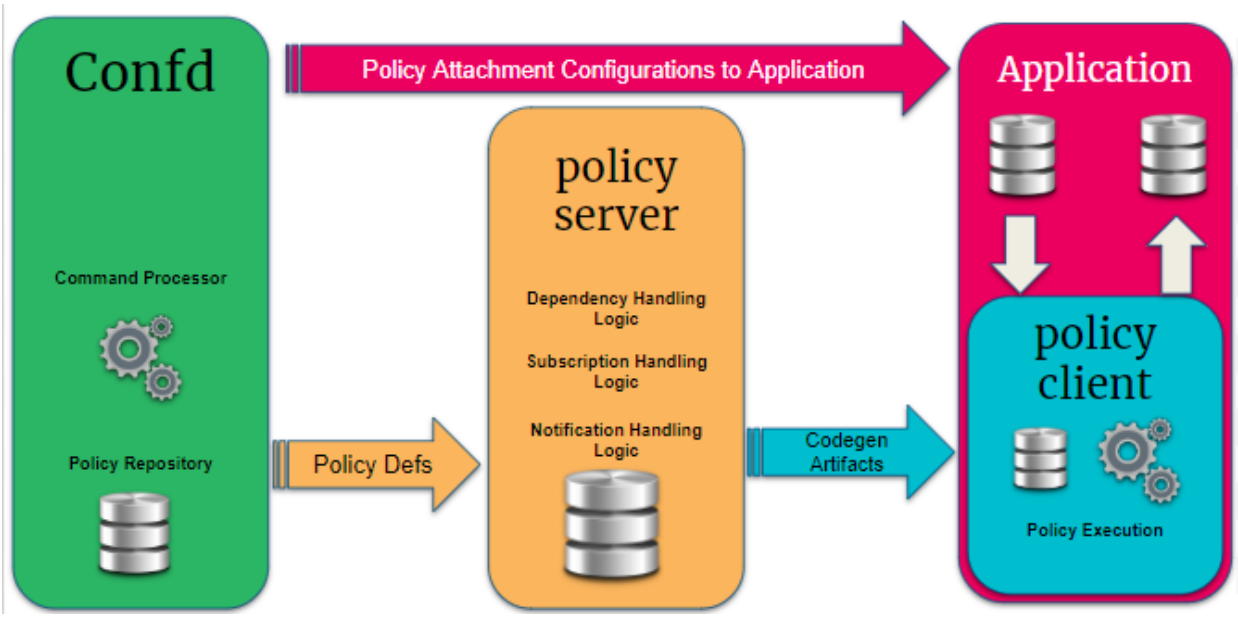


Figure 20. Policy Components

Policy Repository

The policy repository contains all tables related to policy and the associated list of match criteria.

Command Processing Module

The command processing module is part of the configuration daemon (confd), and it handles user interaction with the policy module. This is the back-end of the Command Line Interface (CLI) and JSON configuration that supports the policy configurations.

This module maps the user-defined configuration into the back-end policy object, which is used by the execution engine (after verification), and it ensures that the policy can be correctly executed. This module relays the user intent via related BDS tables to the policy server.

Policy Server

The policy server is a server component that manages all policy rules in the various policy tables and also code generation of the policies.

The following are the functionalities of the policy server:

- Parses the objects in the policy tables and is an execution engine that generates the code to build the policy rules for evaluation, the relationship between various objects, and relays the intent to the evaluation engine.
- Maintains relationships between various policy constructs such as policy statements, rules, ordinals, and lists.
- Tracks the attachment points so that when policies are modified, the appropriate clients are notified of the relevant new policies.
- Flattens the various relationships and generates a notification table that the clients subscribe to obtain notifications based on specific interest groups.
- Uses dependency table relationships to generate jobs to trigger code generation for various policy components.
- On code generation, the policy server updates a notification table that maintains the mapping between the policy server and the client interest groups. The notification table is a single point for the dissemination of information so that it can generate notifications for clients depending on their subscriptions for policy of interest.
- Policy server notification is generated for the policy clients. A notification is received from the notification table with metadata information that notifies the client if this is a new version of the policy or the original version of the policy.

The client uses this information to enforce the policy evaluation and to decide on the version of the policy rule that should be used.

Policy Client

The policy client is a shared library component to which a client daemon, like BGP, IS-IS, OSPF, etc., links. This is the component that performs policy enforcement. It performs the following tasks:

- Links with client daemons like BGP, IS-IS, and OSPF.
- Contains a listener that gets notifications on the availability of a new policy rule that is generated by the policy server.
- Evaluates the compiled rule, and if there are any listeners/ interests, then notifies the components within the client daemon.
- Evaluates any policy configurations on the client daemon and invokes policy processing in response.

Tables and Subscriptions

The table below shows the various tables and their sharing across various policy components.

Tables and Subscriptions

Confd	global.policy.list.config global.policy.list.entry.config global.policy.match.rules.config global.policy.statement.config global.policy.ordinal.config global.policy.mapping.list global.policy.mapping.rules	Policy Statement is composed of one or more policy terms. Each term has a match action criteria. In the match and action criteria, either a single element or a list of elements are compared, and actions are taken. The actions include accept, deny, flow-control, etc.

policy.server	global.policy.dependency global.<bds_name>.policy.subscription global.<bds_name>.policy.notification	Policy Server subscribes to all the tables from confd and creates tables that track policy-entry and dependency and notifies clients after code generation.
policy.client	global.<bds_name>.policy.shared.object.cache global.<bds_name>.policy.subscription global.<bds_name>.policy.context	Subscribes to code generation notifications application context and maintains cache of subscribed .so

Policy Building Blocks

The figure below shows the building blocks of a policy.

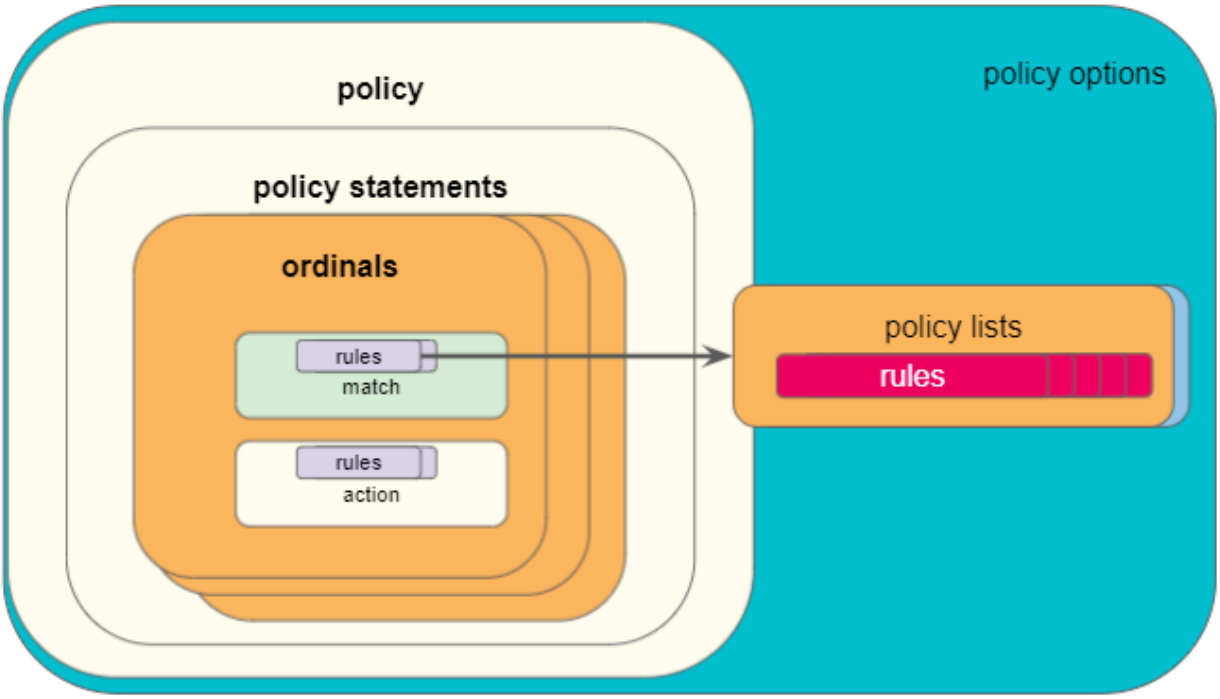


Figure 21. Policy Building Blocks

Statements

A policy is defined by a policy statement. A policy statement is a compound block of policy definition that consists of one or more set of rules called ordinals. A policy statement is exercised in the order defined. The statement name is a globally

unique string that is used to identify the policy, and used by the applications.

The following diagram shows policy statement configuration parameters.



Figure 22. Policy Statement Configuration

Ordinals

A policy ordinal is the smallest block to represent a user policy intent and consists of rules for match and action blocks. The match blocks can either define single independent elements like AS path, IP prefix, IP addresses, community, and so on, or a list of the elements maintained in a different table.

- An ordinal must be a unique number within the scope of a statement which determines the order of the term execution within a policy statement.
- Only a maximum of 16000 ordinals is supported in a policy list.
- If no ordinal exist or configured, and if the policy is used, then all routes or objects will be denied.
- A match logic is defined per ordinal. In case of multiple match rules, it defines if all rules (and), or any of the rules (or) have to match.

Match Rules

Match rules define criteria to evaluate and select routes or other objects to which the policy is applied. One or more match rules compose a match block.

The following diagram shows policy match rule parameters.



Figure 23. Policy Match Rules Configuration

- If the match block results in a successful match ("true"), the corresponding action block will executed.
- If the match block result is unsuccessful ("false"), the action block will not be executed, and the next ordinal will be processed.
- If there is no match block, the action block will be executed.

In case of multiple match rules, the behaviour depends on the configured match logic:

- If the match logic is or, the match block result will be successful ("true") if any one rule matches. Otherwise, by default it is "false".
- If the match logic is and, the match block result will be successful ("true") if all rules match. Otherwise it is "false".

A match rule can refer to a single discrete value, or a list. A policy list is configured separately and referenced from the policy statement. In case of a list match, the behaviour is as follows:

- If any of the list entries matches the configured value, the match block result will be successful ("true"). Otherwise it is "false".
- If the list is defined but empty, the match rule result will be unsuccessful ("false").

Action Rules

Action rules define operations like return-permit or return-deny. The action block will be executed if there is a successful match. Otherwise, the next ordinal is processed. The action block can contain one or multiple action rules. In case of multiple action rules, all actions will be applied. The rules are executed in the order of the rule numbers.

If the action block is not defined, the policy result is return-deny.

The following diagram shows action rules configuration parameters.



Figure 24. Policy Action Rules Configuration

Lists

A policy list is a list of values that can be referenced by a match rule in a policy statement. If you have a number of values like for example route prefixes, it is more efficient to refer to a policy list instead of creating one match rule per prefix.

Policy lists are configured separately and can thereby be maintained more easily. Besides, policy lists can be referenced by multiple policy statements.

Conditions

Policy conditions are configured separately and can be used as an additional option in policy statements. A policy rule (ordinal) will only be executed if the condition is true. Conditional policies allow to make policy execution depended on certain states of the system, for example:

- Protocol neighbor states
- Presence or absence of a specific route and/or path attribute
- Number of routes in a routing table

One condition is supported per ordinal. A single condition can be attached to multiple policies.

Attachment Points

Policies define a set of rules that can be used for various purposes by various applications. Once policies have been created, they need to be applied to take

effect. Attachment points describe the specific applications and processes to which policies can be applied.

The following diagram shows the BGP attachment points.



Figure 25. BGP Attachment Points

RBFS currently supports the following policy attachment points:

- Instance import/export - Policies attached to an instance at the address family level allow to control which routes will be imported into the instance and exported from the instance by BGP. Such import and export policies are commonly used with BGP L3VPNs.

The following diagram shows the BGP Global Instance attachment points.

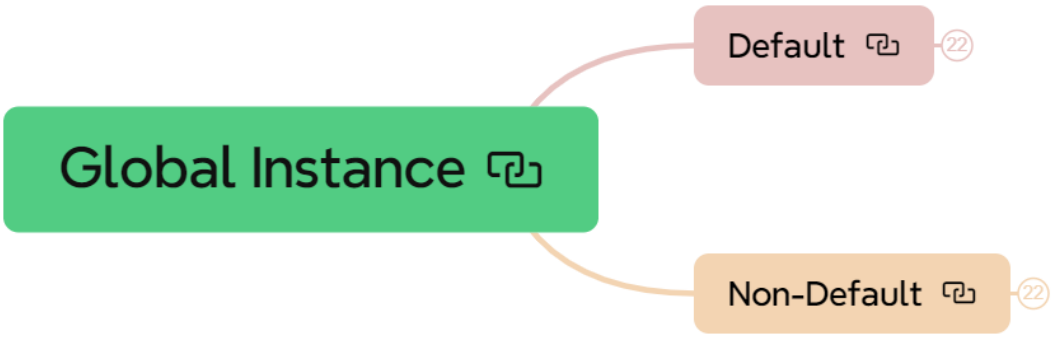


Figure 26. BGP Global Instance Attachment Points

The following diagram shows the BGP Global Instance default attachment points.

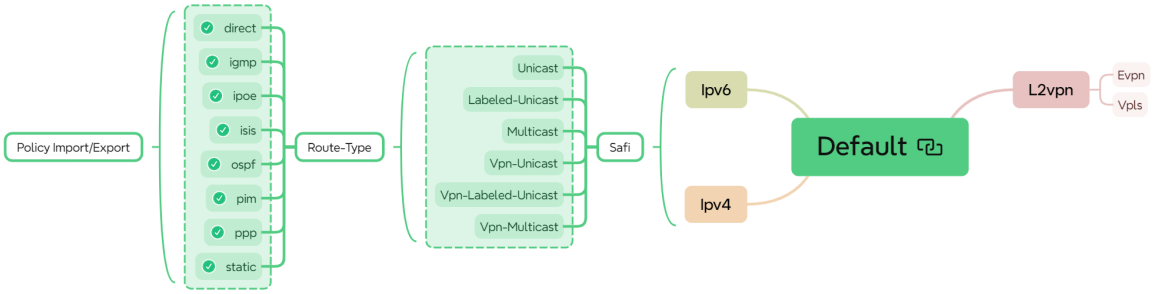


Figure 27. BGP Global Instance Default Attachment Points

The following diagram shows the BGP Global Instance non-default attachment points.

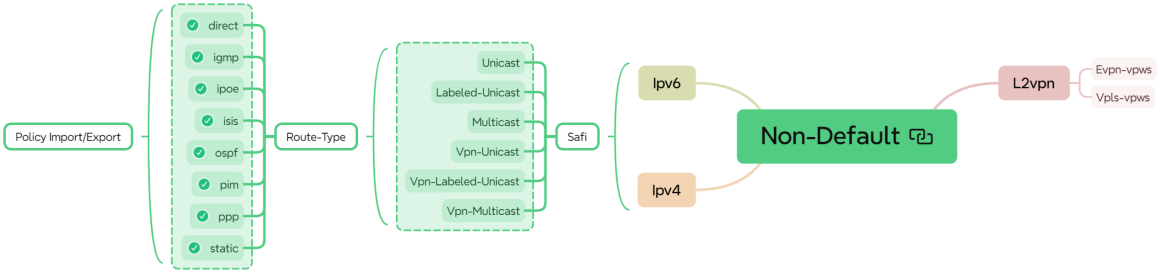


Figure 28. BGP Global Instance Non-Default Attachment Points

- BGP peer group import/export - Policies attached to BGP peer groups allow to define which routes will be advertised to and accepted from BGP peers. You can attach policies to both instances or peer groups to define the import and export behavior. You can also combine both attachment points, for example if some policy rules apply generically to the instance and some other rules specifically to a peer or peer group.

The following diagram shows BGP peer group attachment points.

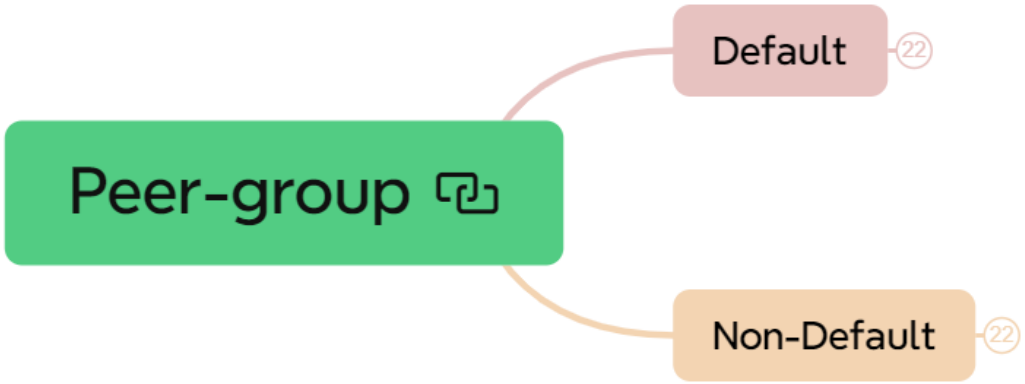


Figure 29. BGP Peer Group Attachment Points

The following diagram shows BGP peer group default attachment points.

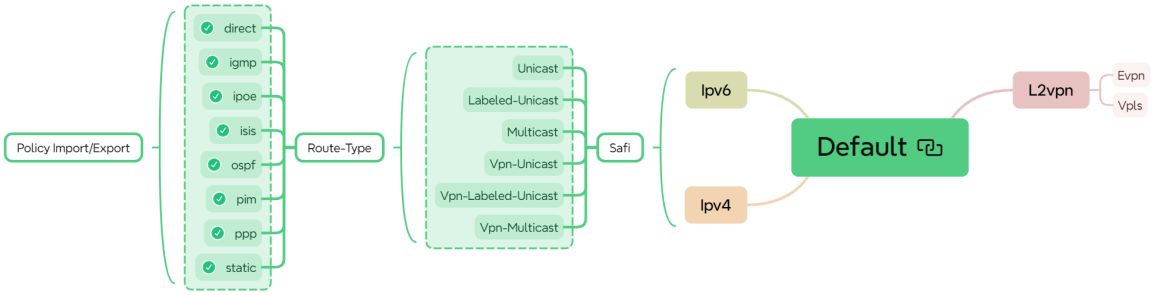


Figure 30. BGP Peer Group Default Attachment Points

The following diagram shows BGP peer group non-default attachment points.

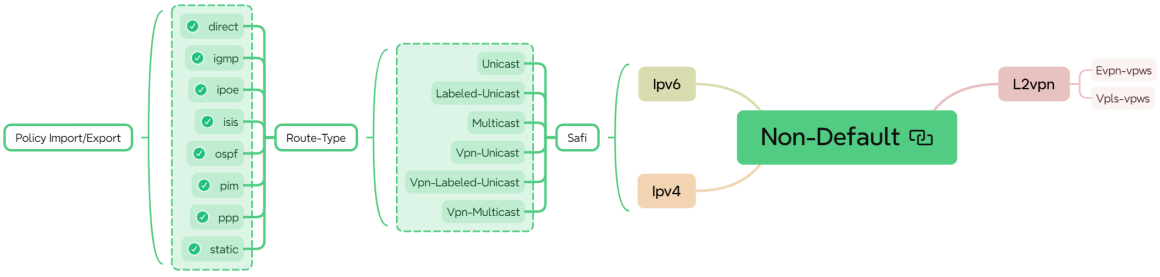


Figure 31. BGP Peer Group Non-Default Attachment Points

- BGP redistribution - You can attach policies to BGP redistribution to define which routes will be redistributed into the BGP process. This is useful if you would like to redistribute only a sub-set of a type of routes.

The following diagram shows BGP redistribution attachment points.

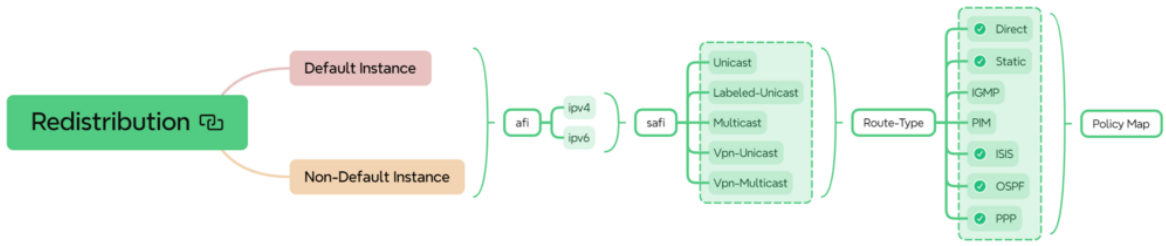


Figure 32. BGP Redistribution Attachment Points

- IS-IS redistribution - Policies can be attached to IS-IS redistribution to control which routes will be redistributed into the IS-IS process.

The following diagram shows IS-IS Redistribution attachment point.

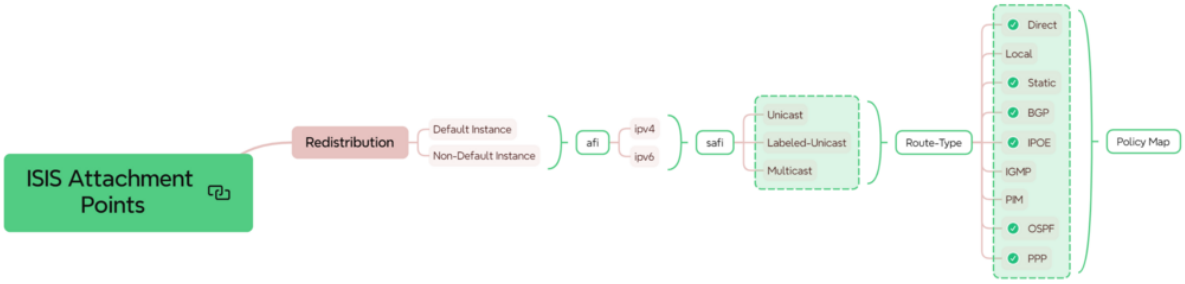


Figure 33. IS-IS Redistribution Attachment Points

- OSPFv2 redistribution - Policies can be attached to OSPFv2 redistribution to control which routes will be redistributed into the OSPFv2 process.

The following diagram shows OSPF Redistribution attachment points.



Figure 34. OSPF Redistribution Attachment Points

- LDP redistribution - Policies can be attached to the LDP redistribution to

control which routes will be redistributed into the LDP process.

The following diagram shows LDP Redistribution attachment points.

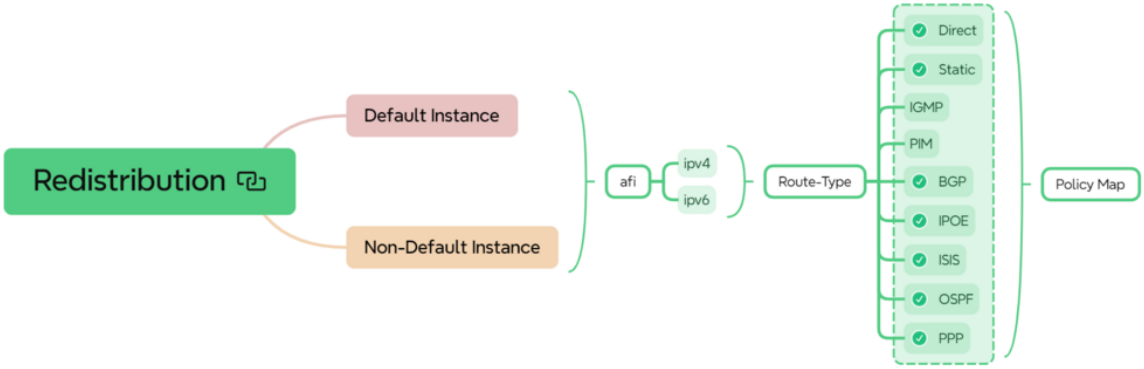


Figure 35. LDP Redistribution Attachment Points

The following diagram shows LDP peer group attachment points.

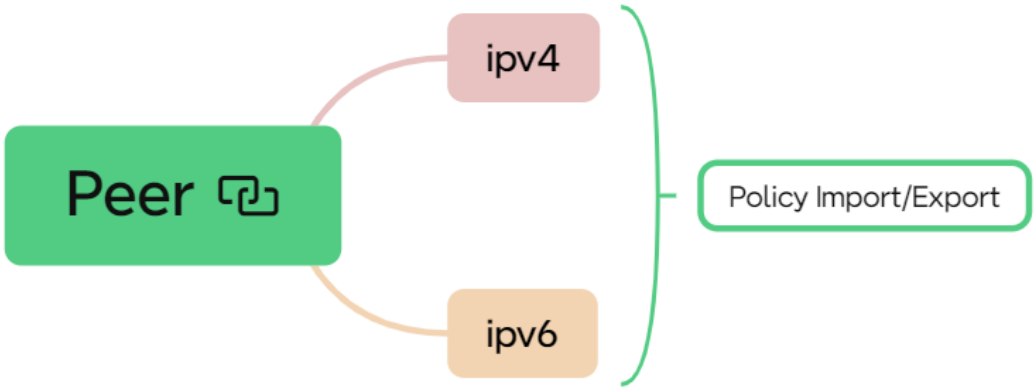


Figure 36. LDP Peer Attachment Points

- IGMP group filtering - You can apply policies to IGMP interface profiles. Such policies act as IGMP group filters when receiving IGMP Membership Report messages.
- IGMP SSM-mapping - Policies are further used to define SSM mapping. SSM mapping policies attached to IGMP interface profiles define how to translate IGMPv2 (*,G) to IGMPv3 (S,G) Reports.

The following diagram shows IGMP attachment points.

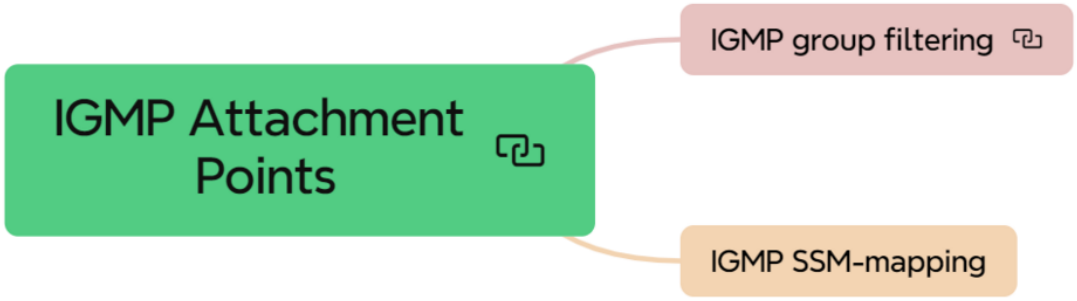


Figure 37. IGMP Attachment Points

Policy Behaviour

The default behaviour of a policy is deny. This means, if a route or any other object is subject to a policy, by default it will be marked as deny if the explicit action permit is not configured for the configured policy. For example import policy for a route, if the route or object successfully matches the match rules, and if there is an action rule configured with operation return-permit, route will be permitted and if return-permit is not configured route will be denied. In addition, further operations like modifying route attributes might be executed.

Policy ordinals are executed in the order of the ordinal numbers.

- If an ordinal results in a terminating action like permit or deny, the policy processing is completed for the respective object, and subsequent ordinals will not be processed.
- If an ordinal does not result in a match, the next ordinal is processed.

There might be situations in which a policy configuration is not complete or not valid. In particular, a policy may contain a match or action type not supported by an attachment point. For example, the ipv4-mcast-group type is not supported by BGP or IS-IS. The following list summarizes the behaviour for such invalid scenarios:

- If a policy contains only statements, or only statements and ordinals, but no match and action block, it will deny all.
- If a match or action type is not supported by the attachment point, the policy will ignore the unsupported rule and process only the supported rules. For any ignored rule, the default deny is not impacted. The behaviour will be the same

as if the unsupported rule does not exist.

Match Type

The Match Type refers to the criteria or conditions used to determine if a particular route or set of routes should be acted upon by the policy. It specifies which attributes of the routes are to be evaluated to see if they meet the policy conditions.

The following diagram shows various match types supported.

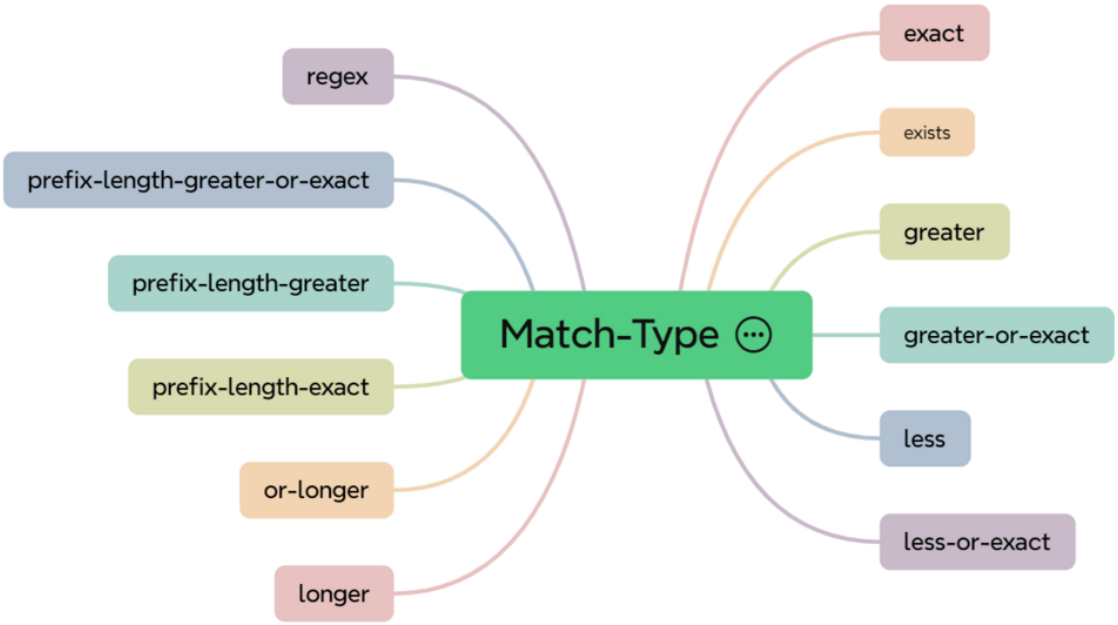


Figure 38. Match Types

Operation Type

The Operation Type refers to the actions applied to the routes that match the specified criteria or match types within the policy. Once a route matches the conditions set by the match types, the operation type dictates what is to be done with the route.

The following diagram shows various operation types supported.

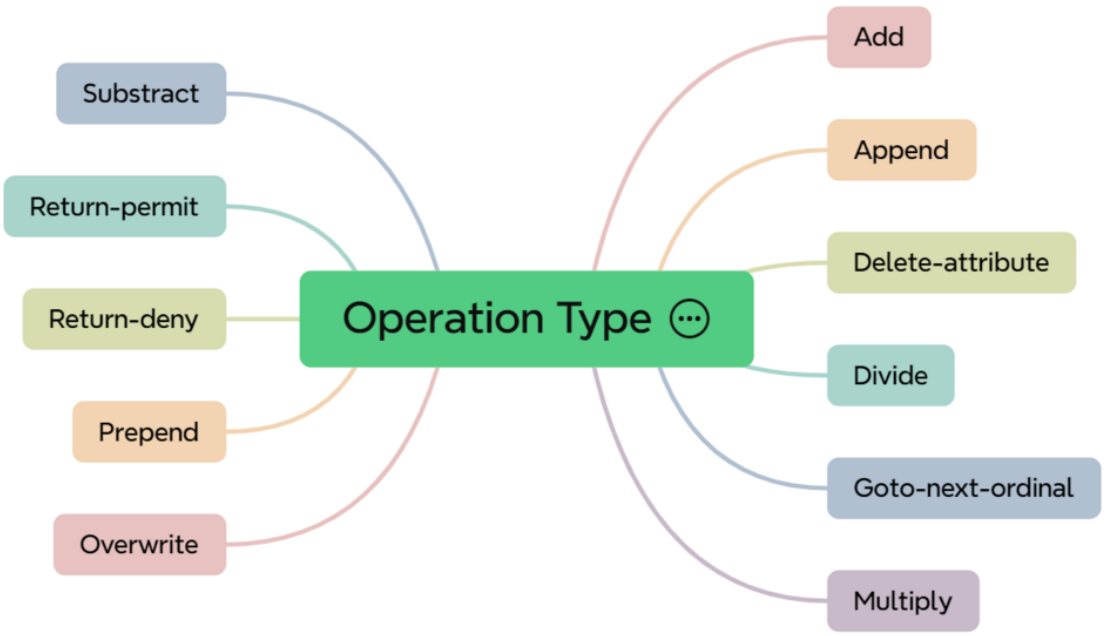


Figure 39. Operation Types

Attribute Type

The Attribute Type refers to the specific properties of routes that can be matched against or modified within the policy. These attributes are used to define conditions (match types) or actions (operation types) on the routes.

The following diagram shows various attribute types supported.

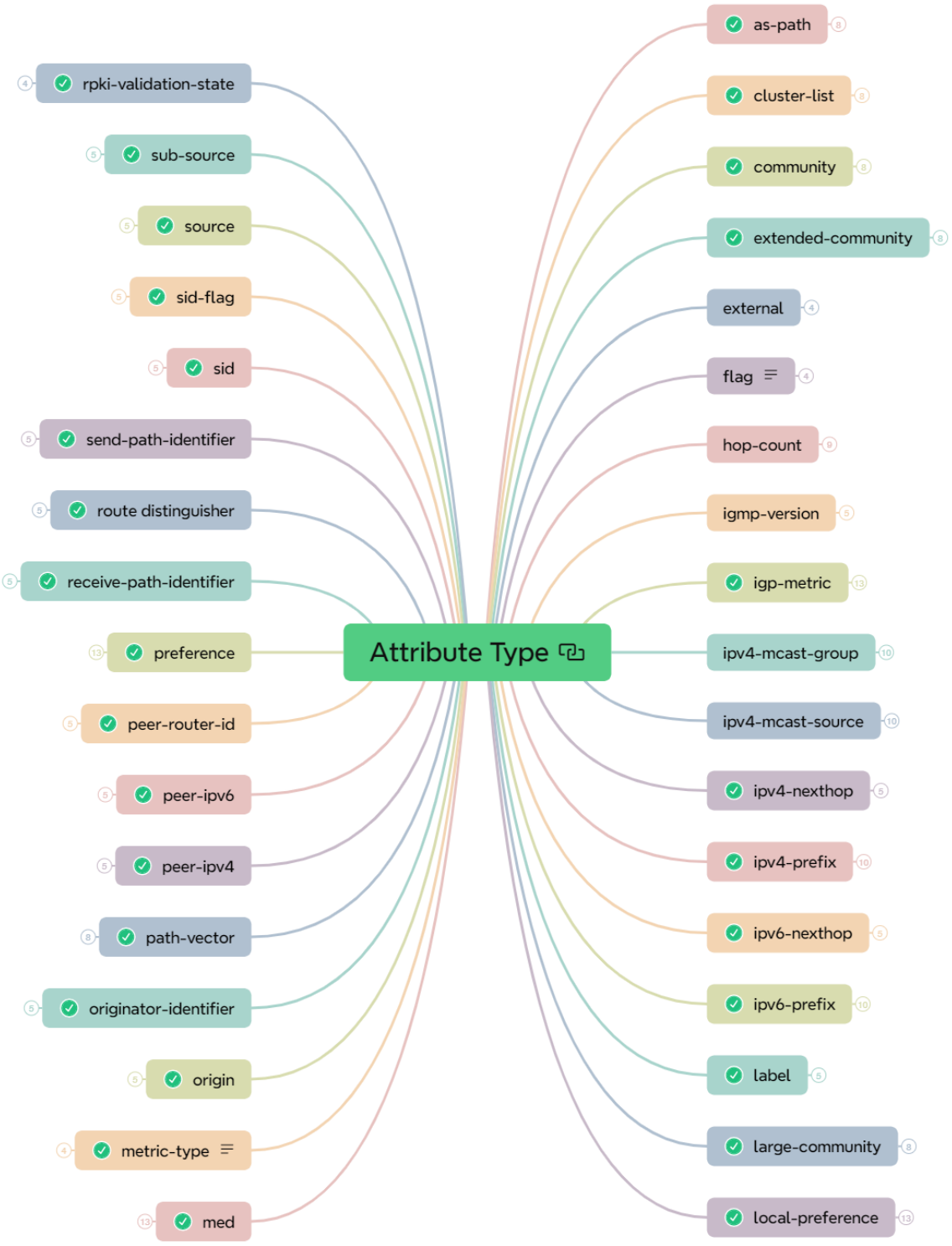


Figure 40. Attribute Types

Policy Chaining

Multiservice edge nodes, such as Broadband Network Gateways (BNG) and peering points, manage routes from various sources. The complexity of policy configurations for these routes can be significant. Certain policies, like filtering private IP addresses and removing private Autonomous System (AS) numbers from

the AS path, are frequently reused across different router application points. Therefore, implementing modularization and enabling the chaining of these policies improve both maintainability and clarity in policy configurations.

Policy chaining is used to modularize monolithic complex routing policies into multiple smaller policies that are executed in a predefined order and are easier to maintain.

Benefits of using policy chaining:

- **Rule Reusability**: Reuse common rules (for example, RFC1918, bogon filtering) across multiple chains, simplifying configuration.
- **Custom Policies**: Create customer-specific policies by combining existing rules for different peering scenarios (transit, upstream, public).
- **Easier Rule Updates**: Simplify updates to general rules affecting multiple policies.
- **Simplify Troubleshooting**: Make troubleshooting easier by breaking down complex configurations into reusable components.

The diagram below shows how a chain of routing policies is evaluated. When Policy Statements 1-3 are chained in configuration, the actual policy evaluation should proceed as shown in the figure below.

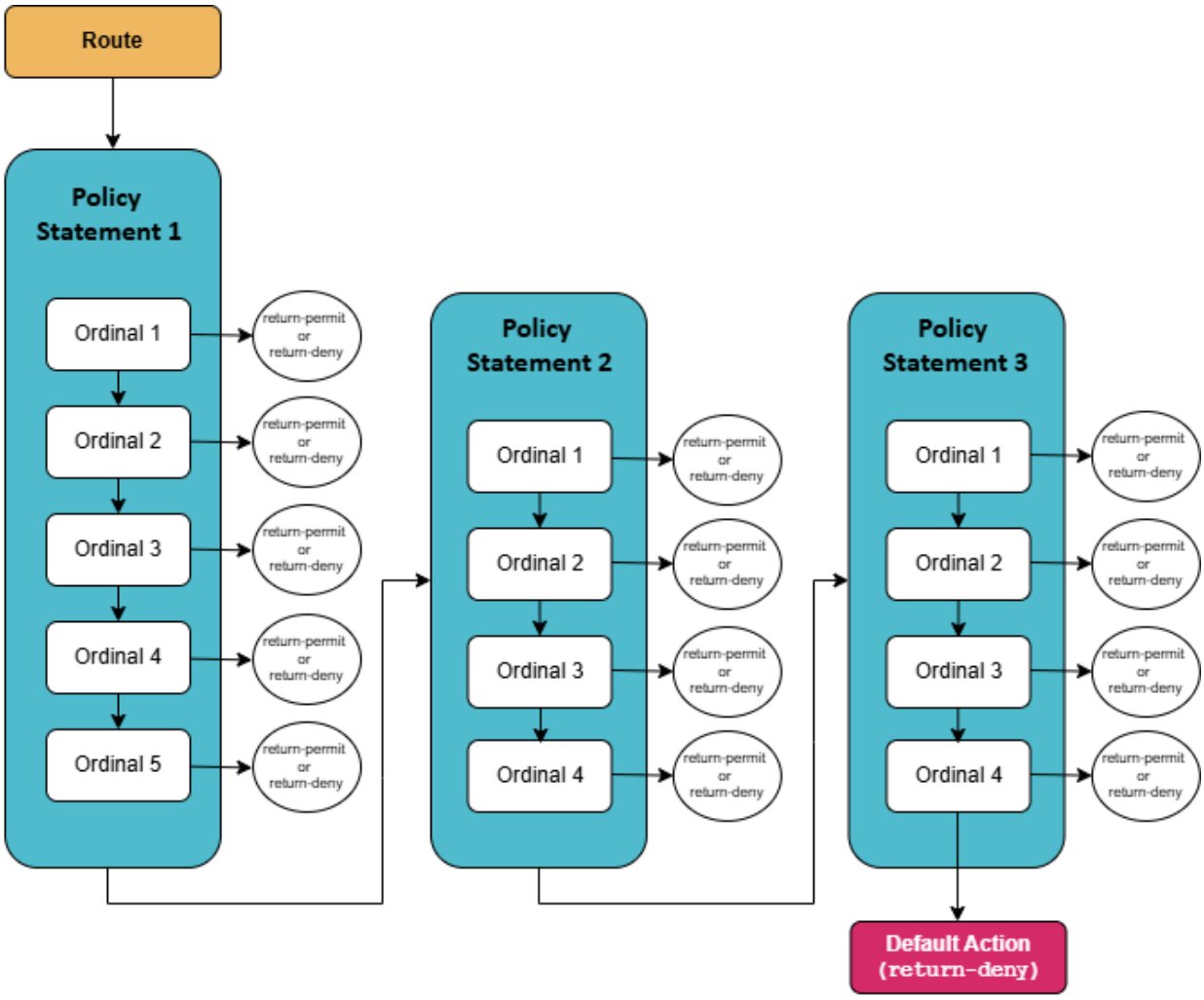


Figure 41. Policy Chaining Workflow

As shown in the diagram, the route is evaluated starting with the first ordinal (Ordinal 1) in the first routing policy (Policy Statement 1).

- If there is a match, the specified action is performed. If the action is to return-permit or return-deny the route, that action is performed, and the evaluation of the route ends.

  If there is no match in the first ordinal (Ordinal 1) of the first routing policy (Policy Statement 1), the evaluation continues by processing the next ordinal (Ordinal 2) and so on.

  If the route does not match any of the ordinals in the first routing policy (Policy Statement 1), the evaluation continues by processing the ordinals of the second routing policy (Policy Statement 2) and so on.

  If there are no more routing policies to evaluate, the evaluation ends as the default action is return-deny.

Support for BGP Community-based Route Leaking Policy

RBFS supports BGP community, extended-community, and large-community as match conditions in route leaking policies. These community attributes can be used to define more flexible route leaking policies.

The table below lists the newly added attributes and match types of route leaking policy.

Match Types Supported for Community Attributes

Attribute Type	Match Types Supported
community	regex exact exists
extended-community	regex exact exists
large-community	regex exact exists

Guidelines and Limitations

The following guidelines and limitations apply to policy configuration and usage:

- Policy cannot be attached without configuring policy statement configuration.
- Conditional policy cannot be attached without policy conditional statement configurations.
- The match value list name cannot be configured under a policy statement without policy list configurations.
- If a policy statement is referenced in any attachment point, users cannot delete the policy statement until its references are removed.
- If a policy conditional statement is referenced in any attachment point, users cannot delete the policy conditional statement until its references are removed.
- If a policy list references a policy statement, users cannot delete the policy list until its references are removed.

Supported Platforms

Not all features are necessarily supported on each hardware platform. Please refer to the RBFS Platform Guide for the features and the sub-features supported or not supported for each platform.

2.9.2. Policy Configuration

Configuration Hierarchy

The diagram illustrates the policy configuration hierarchy.

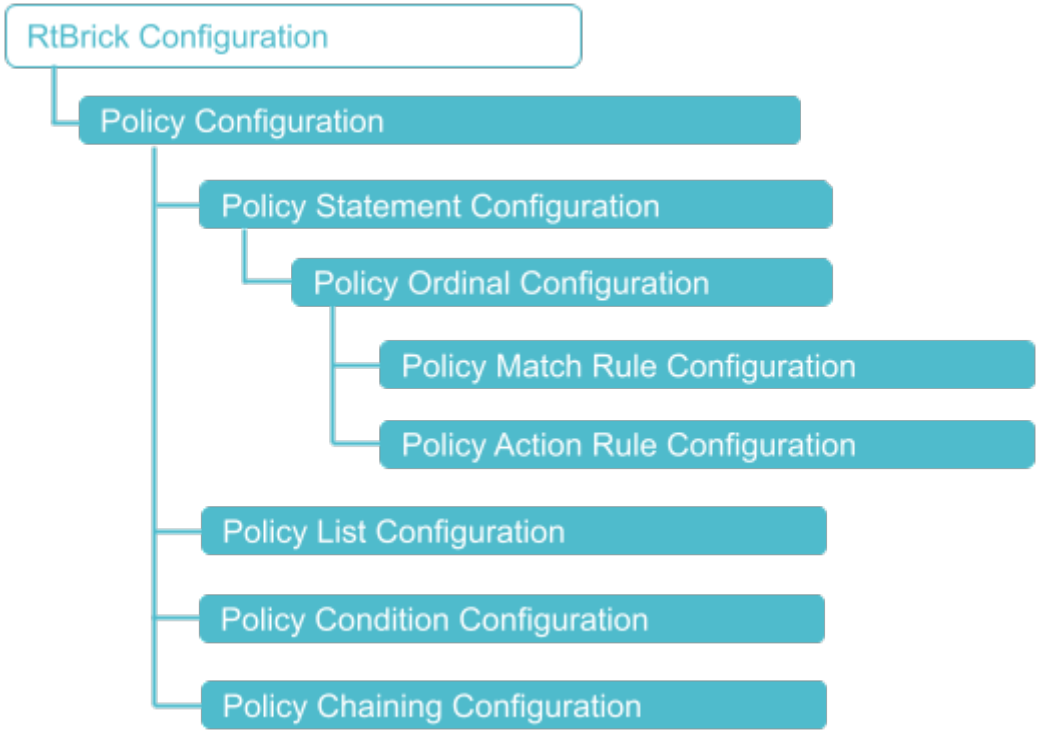


Figure 42. Policy Configuration Hierarchy

Configuration Syntax and Commands

The following sections describe the policy configuration syntax and commands.

Configuring Policy Statements

Syntax:

```
set policy statement <policy-name> ordinal <number> <attribute> <value>
```

Attribute	Description
<policy-name>	Name of the policy statement. Policy names can contain alphanumeric characters and underscore character. They must not include special characters like hyphen. For example, **BGP-EXPORT** is not supported, whereas **BGP_EXPORT** is supported. A valid name cannot start with a number but it can contain numbers and underscore in the string. The length of the names should not exceed 64 characters.
<number>	Specifies the ordinal number.
description <text>	Description of the ordinal.
match <...>	Match configuration hierarchy. Refer to the Configuring Match Rules section for details on the match rule configuration.
match-logic <value>	Specifies the match logic. Supported values are and and or. Default is or.
action <...>	Action configuration hierarchy. Refer to the Action Rule Configuration section for details on the action rule configuration.
condition <condition-name>	Optionally, apply a policy condition. Refer to the Configuring Policy Conditions for the policy condition configuration.

Configuring Match Rules

Syntax:

set policy statement <policy-name> **ordinal** <number> **match rule** <number> <attribute> <value>

Attribute	Description
rule <number>	Specifies the match rule number.
type <attribute-type>	Specifies the attribute type. Refer to the Attribute and Match Types section for details on the supported attribute types.

Attribute	Description
match-type <match-type>	Specifies the match type. Refer to the Attribute and Match Types section for details on the supported match types per attribute, and to the Match Types section for descriptions of the match types.
value <value>	Attribute value. This is the actual value of the attribute to match, for example an IP prefix, a metric, or a community.
value2 <value>	Attribute value2.  While specifying the AS-path, the sub-type "range" allows configuring a range of AS path values. The policy list supports sub-type "range" and ordinal value "value2", which are supported only for AS-path. When sub-type "range" is configured, the "value" (minimum value) and "value2" (maximum value) must be configured.
value-type <value-type>	Attribute value type. Supported value types are: discrete - this is a single value list - this is a list of values defined in a policy list length - to filter RIB entries based on the length of AS paths

Attribute and Match Types

Attribute Type	Match Types Supported
as-path	regex exact exists origin neighbor transit

Attribute Type	Match Types Supported
cluster-list	regex exact exists
community	regex exact exists
extended-community	regex exact exists
external	exact
flag	exact
hop	regex exact lesser greater greater-or-exact lesser-or-exact
igp-metric	regex exact greater greater-or-exact less less-or-exact
igmp-version	regex exact
ipv4-mcast-group	regex exact longer or-longer prefix-length-exact prefix-length-greater prefix-length-greater-or-exact

Attribute Type	Match Types Supported
ipv4-mcast-source	regex exact longer or-longer prefix-length-exact prefix-length-greater prefix-length-greater-or-exact
ipv4-nexthop	regex exact
ipv4-prefix	regex exact longer or-longer prefix-length-exact prefix-length-greater prefix-length-greater-or-exact
ipv6-nexthop	regex exact
ipv6-prefix	regex exact longer or-longer prefix-length-exact prefix-length-greater prefix-length-greater-or-exact
label	regex exact
large-community	regex exact exists

Attribute Type	Match Types Supported
local-preference	regex exact lesser greater greater-or-exact lesser-or-exact
metric-type	exact
med	regex exact lesser greater greater-or-exact lesser-or-exact
origin	regex exact
originator-identifier	regex exact
path-vector	regex exact exists
peer-ipv4	regex exact
peer-ipv6	regex exact
peer-router-id	regex exact
preference	exact lesser greater greater-or-exact lesser-or-exact
receive-path-identifier	regex exact

Attribute Type	Match Types Supported
route-distinguisher	regex exact
rpki-validation-state	exact
send-path-identifier	regex exact
sid	regex exact
source	regex exact
sub-source	regex exact
sid-flag	regex exact

Match Types

Match Types	Description
regex	An attribute can be matched using a standard Linux egrep regular expression. Example: "label": "label-op:push,label:206,bos:1" In this example, the label is a 64bit number, which has label value, bos, and operation encoding. A regex is used to match the string which is displayed in the table dump, that is, label-op:push,label:206,bos:1 not the 64bit value. The same is applicable to an array type attribute. A regex can be written to the string which is visible in the table dump output. For information about Well-known Communities match with Regex, see section "Well-known Communities Regex Match".
exact	Value configured in the command must be same as application attribute value

Match Types	Description
exists	This is applicable only for array type attribute; an exist match is the one where value configured in the command must exist in the application attribute value which is an array.
less	The application attribute value must be less than the value configured in the command
less-or-exact	The application attribute value must be less than or exact value configured in the command
greater	The application attribute value must be greater than the value configured in the command
greater-or-exact	The application attribute value must be greater than or exact value configured in the command
greater-longer	The route shares the same most-significant bits (described by prefix-length), and prefix-length is greater than the route's prefix length
greater-or-longer	The route shares the same most-significant bits (described by prefix-length), and prefix-length is equal to or greater than the route's prefix length.
longer	The route address shares the same most-significant bits as the match prefix (destination-prefix or source-prefix). The number of significant bits is described by the prefix-length component of the match prefix. The match will be performed only for prefixes longer than the one supplied for matching.
or-longer	The route address shares the same most-significant bits as the match prefix (destination-prefix or the source-prefix). The number of significant bits is described by the prefix-length component of the match prefix. The match is performed for the prefix supplied and for any prefixes that are subnets of it.
neighbor	The "neighbor" match-type specifically targets the AS number of the neighboring peer in the RIB entry.
transit	The "transit" match-type matches for AS numbers in rib-entry excluding neighbor and origin.
origin	The "origin" match-type matches for origin as-path number.

Match Types	Description
prefix-length-exact	The application attribute value whose prefix length must be lesser than or exact the value configured in the command
prefix-length-greater	The application attribute value whose prefix length must be greater than the value configured in the command
prefix-length-greater-or-exact	The application attribute value whose prefix length must be greater than or exact value configured in the command

Well-known Communities Regex Match

You must specify the value differently to match well-known communities using regex. For example, you can use the following regex pattern to match well-known communities: NO_EXPORT, NO_ADVERTISE, NO_EXPORT_SUBCONFED, and NOOPER.

This pattern works as follows:

NO* matches any string that starts with NO.

This will successfully match the following well-known communities because they start with NO.

- NO_EXPORT
- NO_ADVERTISE
- "NO_EXPORT_SUBCONFED"
- "NOPEER"

Configuring Action Rules

Syntax:

set policy statement <policy-name> **ordinal** <number> **action rule** <number> <attribute> <value>

Attribute	Description
rule <number>	Specifies the action rule number.
operation <operation-type>	Specifies the operation type. Refer to Operation Types section for details on the supported operations, and to the Attribute Types and Supported Operations section for details on the operations per attribute.
type <attribute-type>	Specifies the attribute type. Refer to section Attribute Types and Supported Operations section for details on the supported attribute types.
value <value>	Specifies the operation value.

Operation Types

Operation Type	Description
add	The application attribute value will be added with the value configured in the command
append	The application attribute value will be appended with the value configured in the command
delete-attribute	Deletes the attribute from the route. It clears all the information for that specific attribute in the object.
delete-attribute-match	Deletes the specific value of an attribute from the route. It is mandatory to define match rules, before configuring the delete-attribute-match action rule.
divide	The application attribute value will be divided with the value configured in the command
goto-next-policy	(Optional). By default, continue with the next policy in the policy chain.
multiply	The application attribute value will be multiplied with the value configured in the command
overwrite	The application attribute value will be overwritten with the value configured in the command
prepend	The application attribute value will be prefixed with the value configured in the command

Operation Type	Description
return-deny	Stops policy execution and returns result as deny (resulting route/BDS object to be denied)
return-permit	Stops policy execution and return result as permit (resulting route/BDS object to be permitted)
subtract	The application attribute value will be subtracted with the value configured in the command. If the result of the subtraction results in a number less than 0, the value "0" is used.

Attribute Types and Supported Operations

Attribute Type	Operation Types Supported
as-path	append prepend overwrite
cluster-list	append prepend overwrite
community	append prepend overwrite
extended-community	append prepend overwrite
external	overwrite
flag	overwrite
hop-count	overwrite
igp-metric	add subtract multiply divide overwrite
igmp-version	overwrite

Attribute Type	Operation Types Supported
ipv4-mcast-group	overwrite
ipv4-mcast-source	overwrite
ipv4-nexthop	overwrite
ipv4-prefix	overwrite
ipv6-nexthop	overwrite
ipv6-prefix	overwrite
label	overwrite
large-community	append prepend overwrite
local-preference	add substract multiply divide overwrite
med	add substract multiply divide overwrite
metric-type	overwrite
origin	overwrite
originator-identifier	overwrite
path-vector	append prepend overwrite
peer-ipv4	overwrite
peer-ipv6	overwrite
peer-router-id	overwrite

Attribute Type	Operation Types Supported
preference	add substract multiply divide overwrite
receive-path-identifier	overwrite
route-distinguisher	overwrite
rpki-validation-state	overwrite
send-path-identifier	overwrite
sid	overwrite
sid-flag	overwrite
source	overwrite
sub-source	overwrite

Example 1: Policy statement configuration

```
{
    "rtbrick-config:policy": {
      "statement": [
        {
          "name": "EXPORT_POLICY1",
          "ordinal": [
            {
              "ordinal": 10,
              "description": "Add BGP community to direct routes",
              "match-logic": "and",
              "match": {
                "rule": [
                  {
                    "rule": 1,
                    "type": "ipv6-prefix",
                    "value-type": "discrete",
                    "match-type": "or-longer",
                    "value": "2001:db8:0:60::/32"
                  },
                  {
                    "rule": 2,
                    "type": "source",
                    "value-type": "discrete",
                    "match-type": "exact",
                    "value": "direct"
                  }
                ]
              },
              "action": {
```

```
              "rule": [
                {
                  "rule": 1,
                  "type": "community",
                  "operation": "append",
                  "value": "100:1"
                },
                {
                  "rule": 2,
                  "operation": "return-permit"
                }
              ]
            }
          },
          {
            "ordinal": 20,
            "description": "Allow any other route",
            "action": {
              "rule": [
                {
                  "rule": 1,
                  "operation": "return-permit"
                }
              ]
            }
          }
        ]
      }
    ]
  }
}
```

Example 2: Policy statement configuration for RPKI Validation State Overwrite

```
{
  "rtbrick-config:policy": {
    "statement": [
      {
        "name": "S1",
        "ordinal": [
          {
            "ordinal": 1,
            "match-logic": "and",
            "match": {
              "rule": [
                {
                  "rule": 1,
                  "type": "rpki-validation-state",
                  "value-type": "discrete",
                  "match-type": "exact",
                  "value": [
                    "invalid"
                    ]
                },
                {
                  "rule": 2,
                  "type": "ipv4-prefix",
                  "value-type": "discrete",
                  "match-type": "exact",
```

```
                  "value": [
                    "192.168.0.11/32"
                    ]
                }
              ]
            },
            "action": {
              "rule": [
                {
                  "rule": 1,
                  "type": "rpki-validation-state",
                  "operation": "overwrite",
                  "value": [
                    "unknown"
                    ]
                },
                {
                  "rule": 2,
                  "operation": "return-permit"
                }
              ]
            }
          }
        ]
      }
    ]
  }
}
```

Configuring Policy Lists

Syntax:

set policy list <list-name> <list-type> **ordinal** <ordinal-number> **value** <value>

Attribute	Description
<list-name>	Name of the policy list

Attribute	Description
<list-type>	Type of the policy list. The following types of lists are supported: - as-path - cluster-list - community - route-distinguisher - extended-community - ipv4-address - ipv4-mcast-group - ipv4-prefix - ipv6-address - ipv6-prefix - large-community - mpls-label - source - sub-source
<ordinal-number>	The number of the list entry.
<value>	The value of the list entry, for example an IP prefix, or a community.

Example: Policy list configuration

```
{
    "rtbrick-config:policy": {
      "list": [
        {
          "name": "PREFIX_LIST1",
          "type": "ipv6-prefix",
          "ordinal": [
            {
              "ordinal": 1,
              "value": "2001:db8:0:10::/32"
            },
            {
              "ordinal": 2,
              "value": "2001:db8:0:25::/32"
            },
            {
              "ordinal": 3,
              "value": "2001:db8:0:30::/32"
            }
          ]
```

```
        }
      ]
    }
}
```

Example: Optimising AS-path Matching

The "neighbor" match-type specifically targets the AS number of the neighboring peer in the RIB entry. For example, the following configuration matches RIB entries whose neighbor AS number is in the "as_neighbor_list", such as 100, 200, or 300.

```
set policy list as_neighbor_list as-path
set policy list as_neighbor_list as-path ordinal 1
set policy list as_neighbor_list as-path ordinal 1 value 100
set policy list as_neighbor_list as-path ordinal 2
set policy list as_neighbor_list as-path ordinal 2 value 200
set policy list as_neighbor_list as-path ordinal 3
set policy list as_neighbor_list as-path ordinal 3 value 300
set policy statement IMPORT_POLICY
set policy statement IMPORT_POLICY ordinal 1
set policy statement IMPORT_POLICY ordinal 1 match
set policy statement IMPORT_POLICY ordinal 1 match rule 1
set policy statement IMPORT_POLICY ordinal 1 match rule 1 type as-path
set policy statement IMPORT_POLICY ordinal 1 match rule 1 value-type list
set policy statement IMPORT_POLICY ordinal 1 match rule 1 match-type neighbor
set policy statement IMPORT_POLICY ordinal 1 match rule 1 value as_neighbor_list
set policy statement IMPORT_POLICY ordinal 1 action
set policy statement IMPORT_POLICY ordinal 1 action rule 1
set policy statement IMPORT_POLICY ordinal 1 action rule 1 operation return-deny
```

The "origin" match-type matches for origin as-path number. For example, the following configuration matches RIB entries whose origin AS number is in the "as_origin_list".

```
set policy list as_origin_list as-path
set policy list as_origin_list as-path ordinal 1
set policy list as_origin_list as-path ordinal 1 value 125
set policy list as_origin_list as-path ordinal 2
set policy list as_origin_list as-path ordinal 2 value 225
set policy list as_origin_list as-path ordinal 3
set policy list as_origin_list as-path ordinal 3 value 325
set policy statement IMPORT_POLICY ordinal 2
set policy statement IMPORT_POLICY ordinal 2 match
set policy statement IMPORT_POLICY ordinal 2 match rule 1
set policy statement IMPORT_POLICY ordinal 2 match rule 1 type as-path
set policy statement IMPORT_POLICY ordinal 2 match rule 1 value-type list
set policy statement IMPORT_POLICY ordinal 2 match rule 1 match-type origin
set policy statement IMPORT_POLICY ordinal 2 match rule 1 value as_origin_list
set policy statement IMPORT_POLICY ordinal 2 action
set policy statement IMPORT_POLICY ordinal 2 action rule 1
set policy statement IMPORT_POLICY ordinal 2 action rule 1 operation return-deny
```

The "transit" match-type matches for AS numbers in rib-entry excluding neighbor and origin.

```
set policy list as_transit_list as-path
set policy list as_transit_list as-path ordinal 1
set policy list as_transit_list as-path ordinal 1 value 150
set policy list as_transit_list as-path ordinal 2
set policy list as_transit_list as-path ordinal 2 value 250
set policy list as_transit_list as-path ordinal 3
set policy list as_transit_list as-path ordinal 3 value 350
set policy statement IMPORT_POLICY ordinal 3
set policy statement IMPORT_POLICY ordinal 3 match
set policy statement IMPORT_POLICY ordinal 3 match rule 1
set policy statement IMPORT_POLICY ordinal 3 match rule 1 type as-path
set policy statement IMPORT_POLICY ordinal 3 match rule 1 value-type list
set policy statement IMPORT_POLICY ordinal 3 match rule 1 match-type transit
set policy statement IMPORT_POLICY ordinal 3 match rule 1 value as_transit_list
set policy statement IMPORT_POLICY ordinal 3 action
set policy statement IMPORT_POLICY ordinal 3 action rule 1
set policy statement IMPORT_POLICY ordinal 3 action rule 1 operation return-deny
```

The sub-type "range" allows configuring a range of AS path values. The policy list supports sub-type "range" and ordinal value "value2", which are supported only for AS-path. When sub-type "range" is configured, the "value" (minimum value) and "value2" (maximum value) must be configured.

```
set policy list BOGON_ASNS as-path
set policy list BOGON_ASNS as-path sub-type range
set policy list BOGON_ASNS as-path ordinal 1
set policy list BOGON_ASNS as-path ordinal 1 value 0
set policy list BOGON_ASNS as-path ordinal 1 value2 0
set policy list BOGON_ASNS as-path ordinal 2
set policy list BOGON_ASNS as-path ordinal 2 value 23456
set policy list BOGON_ASNS as-path ordinal 2 value2 23456
set policy list BOGON_ASNS as-path ordinal 3
set policy list BOGON_ASNS as-path ordinal 3 value 64496
set policy list BOGON_ASNS as-path ordinal 3 value2 64511
set policy list BOGON_ASNS as-path ordinal 4
set policy list BOGON_ASNS as-path ordinal 4 value 65536
set policy list BOGON_ASNS as-path ordinal 4 value2 65551
set policy list BOGON_ASNS as-path ordinal 5
set policy list BOGON_ASNS as-path ordinal 5 value 4200000000
set policy list BOGON_ASNS as-path ordinal 5 value2 4294967294
set policy list BOGON_ASNS as-path ordinal 6
set policy list BOGON_ASNS as-path ordinal 6 value 65535
set policy list BOGON_ASNS as-path ordinal 6 value2 65535
set policy list BOGON_ASNS as-path ordinal 7
set policy list BOGON_ASNS as-path ordinal 7 value 4294967294
set policy list BOGON_ASNS as-path ordinal 7 value2 4294967294
set policy list BOGON_ASNS as-path ordinal 8
set policy list BOGON_ASNS as-path ordinal 8 value 65552
set policy list BOGON_ASNS as-path ordinal 8 value2 131071

set policy statement BOGON_ASN_FILTERING
set policy statement BOGON_ASN_FILTERING ordinal 1
```

```
set policy statement BOGON_ASN_FILTERING ordinal 1 match
set policy statement BOGON_ASN_FILTERING ordinal 1 match rule 1
set policy statement BOGON_ASN_FILTERING ordinal 1 match rule 1 type as-path
set policy statement BOGON_ASN_FILTERING ordinal 1 match rule 1 value-type list
set policy statement BOGON_ASN_FILTERING ordinal 1 match rule 1 match-type exists
set policy statement BOGON_ASN_FILTERING ordinal 1 match rule 1 value BOGON_ASNS
set policy statement BOGON_ASN_FILTERING ordinal 1 action
set policy statement BOGON_ASN_FILTERING ordinal 1 action rule 1
set policy statement BOGON_ASN_FILTERING ordinal 1 action rule 1 operation return-
deny
```

Also, network operators may need to match AS-path length to detect bogus announcements. For example, drop all AS-paths with lengths greater than 100. To support this, a new value type, "length" has been added, which supports the match type "greater-or-exact."

```
set policy statement CHECK_LENGTH
set policy statement CHECK_LENGTH ordinal 1
set policy statement CHECK_LENGTH ordinal 1 match
set policy statement CHECK_LENGTH ordinal 1 match rule 1
set policy statement CHECK_LENGTH ordinal 1 match rule 1 type as-path
set policy statement CHECK_LENGTH ordinal 1 match rule 1 value-type length
set policy statement CHECK_LENGTH ordinal 1 match rule 1 match-type greater-or-
exact
set policy statement CHECK_LENGTH ordinal 1 match rule 1 value 10
set policy statement CHECK_LENGTH ordinal 1 action
set policy statement CHECK_LENGTH ordinal 1 action rule 1
set policy statement CHECK_LENGTH ordinal 1 action rule 1 operation return-permit
```

Configuring Policy Conditions

Policy conditions refer to certain states of the system represented in BDS tables. You need to specify the table, the daemon (BD) that needs to resolve the condition, and if applicable, the attributes used to define the condition.

There are two types of conditions:

- Match on certain attributes in BDS table objects.
- Match on the number of objects in a BDS table.

Configuring Table Match

Syntax:

set policy condition <condition-name> **table** <attribute> <value>

Attribute	Description
<condition-name>	Name of the policy condition
name <table-name>	Name of the BDS table
bd <bd-name>	Name of the BD which resolves the condition. Currently supported BDs are: ifmd, ribd, mribd, pppoed, subscriberd, ipoed, l2tpd, pimd, igmp.iod, isis.iod, ospf.appd ospf.iod
count <number>	Optionally, match on the number of objects in a table
match <type>	Type of match for an object count. Supported match types are: equal greater greater-or-equal less less-or-equal

Configuring Attribute Match

You can configure attributes to define a condition. The attributes refer to objects in the table configured in the section above. Please note:

- You can match on multiple attributes.
- In order to identify matching objects, you need to specify all attributes which are primary keys in the table.
- Attribute configuration is not required for conditions matching on the number of table objects using the count option.

Syntax:

```
set policy condition <condition-name> attribute <name> <attribute> <value>
```

Attribute	Description
<condition-name>	Name of the policy condition
attribute <name>	Name of the attribute in the BDS table

Attribute	Description
value <value>	Value of the attribute to match
match <type>	Type of the match. Supported match types are: equal exists greater greater-or-equal less less-or-equal regex

Example: Policy condition configuration

```
{
    "rtbrick-config:policy": {
      "condition": [
        {
          "condition_name": "precheck",
          "table": {
            "name": "global.instance",
            "bd": "bgp.iod.1"
          },
          "attribute": [
            {
              "name": "instance_name",
              "match": "equal",
              "value": "default"
            }
          ]
        }
      ]
    }
  }
```

Attaching Policies

Once a policy has been created, they need to be applied to an application like a routing protocol to take effect.

BGP Attachment Points

- Instance import/export
- BGP peer group import/export
- BGP redistribution

For attaching policies to the BGP protocol, please refer to the RBFS BGP User Guide.

IS-IS Attachment Points

- IS-IS redistribution

For attaching policies to the IS-IS protocol, please refer to the IS-IS User Guide.

OSPFv2 Attachment Points

- OSPFv2 redistribution

For attaching policies to the OSPFv2/v3 protocol, please refer to the OSPFv2 User Guide.

LDP Attachment Points

- LDP redistribution#

For attaching policies to the LDP protocol, please refer to the LDP User Guide.

IGMP Attachment Points

- IGMP group filtering
- IGMP SSM-mapping

For attaching policies to the IGMP protocol, please refer to the RBFS IP Multicast Routing Configuration Guide.

Policy Chaining Configuration

The following configuration demonstrates how policy chaining is applied for the PEERING_V4 BGP peer group. For IPv4 unicast address family, incoming routes will be evaluated and imported only if they meet the criteria defined in the associated import policies. These policies provide layered route filtering, ensuring that only valid and desired routes are accepted by the peer.

The configuration applies a series of import policies for the IPv4 unicast address family. These policies are chained in sequence, each performing specific tasks such as:

- Filtering bogon IPs (FILTER_BOGONS_V4).
- Preventing the import of the peer's own IP ranges (FILTER_OWN_V4).
- Scrubbing unwanted community tags (SCRUB_COMMUNITIES).

The following example shows the policy chaining configuration for the peer-group "PEERING_V4."

```
set instance default protocol bgp peer-group PEERING_V4
set instance default protocol bgp peer-group PEERING_V4 remote-as 65536
set instance default protocol bgp peer-group PEERING_V4 address-family ipv4
labeled-unicast
set instance default protocol bgp peer-group PEERING_V4 address-family ipv4
unicast
set instance default protocol bgp peer-group PEERING_V4 address-family ipv4
unicast policy import FILTER_BOGONS_V4
set instance default protocol bgp peer-group PEERING_V4 address-family ipv4
unicast policy import FILTER_OWN_V4
set instance default protocol bgp peer-group PEERING_V4 address-family ipv4
unicast policy import SCRUB_COMMUNITIES
```

```
supervisor@rtbrick>SPINE01: cfg> show config instance default protocol bgp peer-
group PEERING_V4
{
  "rtbrick-config:peer-group": [
    {
      "pg-name": "PEERING_V4",
      "remote-as": 65536,
      "address-family": [
        {
          "afi": "ipv4",
          "safi": "labeled-unicast"
        },
        {
          "afi": "ipv4",
          "safi": "unicast",
          "policy": {
            "import": [
              "FILTER_BOGONS_V4",
              "FILTER_OWN_V4",
              "SCRUB_COMMUNITIES"              ]
          }
        },
        {
          "afi": "ipv6",
          "safi": "labeled-unicast"
        },
        {
          "afi": "ipv6",
          "safi": "unicast"
        }
      ]
    }
  ]
```

```
}
```

Policy Statement Configurations for Policy Chaining

The following configurations provide a detailed representation of the policy statements utilized in the aforementioned policy chaining example.

The example below shows the policy definitions for the FILTER_BOGONS_V4 policy statement.

```
set policy statement FILTER_BOGONS_V4
set policy statement FILTER_BOGONS_V4 ordinal 1
set policy statement FILTER_BOGONS_V4 ordinal 1 description FILTER_BOGONS
set policy statement FILTER_BOGONS_V4 ordinal 1 match-logic or
set policy statement FILTER_BOGONS_V4 ordinal 1 match
set policy statement FILTER_BOGONS_V4 ordinal 1 match rule 1
set policy statement FILTER_BOGONS_V4 ordinal 1 match rule 1 type ipv4-prefix
set policy statement FILTER_BOGONS_V4 ordinal 1 match rule 1 value-type list
set policy statement FILTER_BOGONS_V4 ordinal 1 match rule 1 match-type or-longer
set policy statement FILTER_BOGONS_V4 ordinal 1 match rule 1 value FILTER_BOGONS
set policy statement FILTER_BOGONS_V4 ordinal 1 match rule 2
set policy statement FILTER_BOGONS_V4 ordinal 1 match rule 2 type ipv4-prefix
set policy statement FILTER_BOGONS_V4 ordinal 1 match rule 2 value-type discrete
set policy statement FILTER_BOGONS_V4 ordinal 1 match rule 2 match-type regex
set policy statement FILTER_BOGONS_V4 ordinal 1 match rule 2 value 0.0.0.0/(2[5-
9]|3[0-1])
set policy statement FILTER_BOGONS_V4 ordinal 1 action
set policy statement FILTER_BOGONS_V4 ordinal 1 action rule 1
set policy statement FILTER_BOGONS_V4 ordinal 1 action rule 1 operation return-
deny
set policy statement FILTER_BOGONS_V4 ordinal 2
set policy statement FILTER_BOGONS_V4 ordinal 2 description FILTER_IXP
set policy statement FILTER_BOGONS_V4 ordinal 2 match
set policy statement FILTER_BOGONS_V4 ordinal 2 match rule 1
set policy statement FILTER_BOGONS_V4 ordinal 2 match rule 1 type ipv4-prefix
set policy statement FILTER_BOGONS_V4 ordinal 2 match rule 1 value-type list
set policy statement FILTER_BOGONS_V4 ordinal 2 match rule 1 match-type or-longer
set policy statement FILTER_BOGONS_V4 ordinal 2 match rule 1 value
IXP_PEERING_LANS_V4
set policy statement FILTER_BOGONS_V4 ordinal 2 action
set policy statement FILTER_BOGONS_V4 ordinal 2 action rule 1
set policy statement FILTER_BOGONS_V4 ordinal 2 action rule 1 operation return-
deny
```

The example below shows the configurations of the ‘FILTER_BOGONS’ policy list used in the ‘FILTER_BOGONS_V4’ policy statement.

```
supervisor@S1-STD-2-2004>bm04-tst.fsn.rtbrick.net: op> show config set policy list
FILTER_BOGONS
set policy list FILTER_BOGONS ipv4-prefix
set policy list FILTER_BOGONS ipv4-prefix ordinal 1
set policy list FILTER_BOGONS ipv4-prefix ordinal 1 value 0.0.0.0/8
set policy list FILTER_BOGONS ipv4-prefix ordinal 2
```

```
set policy list FILTER_BOGONS ipv4-prefix ordinal 2 value 10.0.0.0/8
set policy list FILTER_BOGONS ipv4-prefix ordinal 3
set policy list FILTER_BOGONS ipv4-prefix ordinal 3 value 100.64.0.0/10
set policy list FILTER_BOGONS ipv4-prefix ordinal 4
set policy list FILTER_BOGONS ipv4-prefix ordinal 4 value 127.0.0.0/8
```

The example below shows the configurations of the 'IXP_PEERING_LANS_V4' policy list used in the 'FILTER_BOGONS_V4' policy statement.

```
set policy list IXP_PEERING_LANS_V4 ipv4-prefix
set policy list IXP_PEERING_LANS_V4 ipv4-prefix ordinal 1
set policy list IXP_PEERING_LANS_V4 ipv4-prefix ordinal 1 value 80.81.192.0/21
set policy list IXP_PEERING_LANS_V4 ipv4-prefix ordinal 2
set policy list IXP_PEERING_LANS_V4 ipv4-prefix ordinal 2 value 80.249.208.0/21
set policy list IXP_PEERING_LANS_V4 ipv4-prefix ordinal 3
set policy list IXP_PEERING_LANS_V4 ipv4-prefix ordinal 3 value 91.213.211.0/24
set policy list IXP_PEERING_LANS_V4 ipv4-prefix ordinal 4
set policy list IXP_PEERING_LANS_V4 ipv4-prefix ordinal 4 value 185.0.20.0/23
```

The example below shows the policy definitions for the FILTER_OWN_V4 policy statement.

```
set policy statement FILTER_OWN_V4
set policy statement FILTER_OWN_V4 ordinal 1
set policy statement FILTER_OWN_V4 ordinal 1 match
set policy statement FILTER_OWN_V4 ordinal 1 match rule 1
set policy statement FILTER_OWN_V4 ordinal 1 match rule 1 type ipv4-prefix
set policy statement FILTER_OWN_V4 ordinal 1 match rule 1 value-type list
set policy statement FILTER_OWN_V4 ordinal 1 match rule 1 match-type or-longer
set policy statement FILTER_OWN_V4 ordinal 1 match rule 1 value MYPREFIXES_V4
set policy statement FILTER_OWN_V4 ordinal 1 action
set policy statement FILTER_OWN_V4 ordinal 1 action rule 1
set policy statement FILTER_OWN_V4 ordinal 1 action rule 1 operation return-deny
```

The example below shows the configurations of the 'MYPREFIXES_V4' policy list used in the 'FILTER_OWN_V4' policy statement.

```
set policy list MYPREFIXES_V4 ipv4-prefix
set policy list MYPREFIXES_V4 ipv4-prefix ordinal 1
set policy list MYPREFIXES_V4 ipv4-prefix ordinal 1 value 192.0.2.0/24
set policy list MYPREFIXES_V4 ipv4-prefix ordinal 2
set policy list MYPREFIXES_V4 ipv4-prefix ordinal 2 value 198.51.100.0/24
set policy list MYPREFIXES_V4 ipv4-prefix ordinal 3
set policy list MYPREFIXES_V4 ipv4-prefix ordinal 3 value 203.0.113.0/24
```

The example below shows the policy definitions for the SCRUB_COMMUNITIES policy statement.

```
set policy statement SCRUB_COMMUNITIES
```

```
set policy statement SCRUB_COMMUNITIES ordinal 1
set policy statement SCRUB_COMMUNITIES ordinal 1 match
set policy statement SCRUB_COMMUNITIES ordinal 1 match rule 1
set policy statement SCRUB_COMMUNITIES ordinal 1 match rule 1 type community
set policy statement SCRUB_COMMUNITIES ordinal 1 match rule 1 value-type discrete
set policy statement SCRUB_COMMUNITIES ordinal 1 match rule 1 match-type regex
set policy statement SCRUB_COMMUNITIES ordinal 1 match rule 1 value 64496:*
set policy statement SCRUB_COMMUNITIES ordinal 1 action
set policy statement SCRUB_COMMUNITIES ordinal 1 action rule 1
set policy statement SCRUB_COMMUNITIES ordinal 1 action rule 1 type community
set policy statement SCRUB_COMMUNITIES ordinal 1 action rule 1 operation delete-
attribute-match
set policy statement SCRUB_COMMUNITIES ordinal 1 action rule 2 operation return-
permit
```

Sample Configurations

Example 1: BGP export policy referencing a policy list

```
supervisor@leaf1: cfg> show config policy
{
  "rtbrick-config:policy": {
    "list": [
      {
        "name": "PREFIX_LIST2",
        "type": "ipv6-prefix",
        "ordinal": [
          {
            "ordinal": 1,
            "value": "2001:db8:0:60::/32"
          },
          {
            "ordinal": 2,
            "value": "2001:db8:0:80::/64"
          },
          {
            "ordinal": 3,
            "value": "2001:db8:0:110::/64 "
          }
        ]
      }
    ],
    "statement": [
      {
        "name": "EXPORT_POLICY2",
        "ordinal": [
          {
            "ordinal": 10,
            "description": "Add community to direct routes",
            "match": {
              "rule": [
                {
                  "rule": 1,
                  "type": "source",
                  "value-type": "discrete",
                  "match-type": "exact",
                  "value": "direct"
```

```
                }
              ]
            },
            "action": {
              "rule": [
                {
                  "rule": 1,
                  "type": "community",
                  "operation": "append",
                  "value": "100:1"
                },
                {
                  "rule": 2,
                  "operation": "return-permit"
                }
              ]
            }
          },
          {
            "ordinal": 20,
            "description": "Allow list of routes",
            "match": {
              "rule": [
                {
                  "rule": 1,
                  "type": "ipv6-prefix",
                  "value-type": "list",
                  "match-type": "or-longer",
                  "value": "PREFIX_LIST2"
                }
              ]
            },
            "action": {
              "rule": [
                {
                  "rule": 1,
                  "operation": "return-permit"
                }
              ]
            }
          },
          {
            "ordinal": 30,
            "description": "Deny any other route",
            "action": {
              "rule": [
                {
                  "rule": 1,
                  "operation": "return-deny"
                }
              ]
            }
          }
        ]
      }
    ]
  }
}
```

```
supervisor@leaf1: cfg> show config instance default protocol bgp peer-group spine
address-family ipv6 unicast
{
  "rtbrick-config:address-family": [
    {
      "afi": "ipv6",
      "safi": "unicast",
      "policy": {
        "export": "EXPORT_POLICY2"
      }
    }
  ]
}
```

Example 2: IGMP filter policy

```
supervisor@leaf1: cfg> show config policy
{
  "rtbrick-config:policy": {
    "statement": [
      {
        "name": "IGMP_FILTER",
        "ordinal": [
          {
            "ordinal": 1,
            "description": "IGMP group filter",
            "match-logic": "or",
            "match": {
              "rule": [
                {
                  "rule": 1,
                  "type": "ipv4-mcast-group",
                  "value-type": "discrete",
                  "match-type": "or-longer",
                  "value": "198.51.100.0/24"
                },
                {
                  "rule": 2,
                  "type": "ipv4-mcast-group",
                  "value-type": "discrete",
                  "match-type": "or-longer",
                  "value": "198.51.100.0/24"
                }
              ]
            },
            "action": {
              "rule": [
                {
                  "rule": 1,
                  "operation": "return-permit"
                }
              ]
            }
          }
        ]
      }
    ]
  }
```

```
}
```

```
supervisor@leaf1: cfg> show config multicast-options igmp
{
  "rtbrick-config:igmp": {
    "interface-profile": [
      {
        "profile-name": "PROFILE1",
        "filter-policy": "IGMP_FILTER"
      }
    ]
  }
}
```

Example 4: Community Deletion Configuration

```
supervisor@rtbrick: cfg> show config policy
{
  "rtbrick-config:policy": {
    "statement": [
      {
        "name": "test_policy",
        "ordinal": [
          {
            "ordinal": 1,
            "match-logic": "or",
            "match": {
              "rule": [
                {
                  "rule": 1,
                  "type": "community",
                  "value-type": "discrete",
                  "match-type": "exists",
                  "value": [
                    "1:1"
                    ]
                },
                {
                  "rule": 2,
                  "type": "extended-community",
                  "value-type": "discrete",
                  "match-type": "exists",
                  "value": [
                    "target:3.3.3.3:3000",
                    "target:5.5.5.5:5000"
                    ]
                },
                {
                  "rule": 3,
                  "type": "large-community",
                  "value-type": "discrete",
                  "match-type": "exists",
                  "value": [
                    "3333:33333:33",
                    "4444:44444:44"
                    ]
                },
```

```
                {
                  "rule": 4,
                  "type": "community",
                  "value-type": "discrete",
                  "match-type": "regex",
                  "value": [
                    "555:*"
                    ]
                }
              ]
            },
            "action": {
              "rule": [
                {
                  "rule": 1,
                  "type": "community",
                  "operation": "delete-attribute-match"
                },
                {
                  "rule": 2,
                  "type": "extended-community",
                  "operation": "delete-attribute-match"
                },
                {
                  "rule": 3,
                  "type": "large-community",
                  "operation": "delete-attribute-match"
                },
                {
                  "rule": 4,
                  "operation": "return-permit"
                }
              ]
            }
          }
        ]
      }
    ]
  }
}
```

Matching ARP-ND Source in Policy

The example below configures a policy statement named ARP_ND_SOURCE_MATCH. It defines a rule (ordinal 1) that matches traffic of type arp-nd and appends the community 111:111 to it, with a final rule (ordinal 99) set to permit all other traffic.

```
set policy statement ARP_ND_SOURCE_MATCH
set policy statement ARP_ND_SOURCE_MATCH ordinal 1
set policy statement ARP_ND_SOURCE_MATCH ordinal 1 description
ARP_ND_POLICY_SOURCE_COM_ADD
set policy statement ARP_ND_SOURCE_MATCH ordinal 1 match
set policy statement ARP_ND_SOURCE_MATCH ordinal 1 match rule 1
set policy statement ARP_ND_SOURCE_MATCH ordinal 1 match rule 1 type source
set policy statement ARP_ND_SOURCE_MATCH ordinal 1 match rule 1 value-type
```

```
discrete
set policy statement ARP_ND_SOURCE_MATCH ordinal 1 match rule 1 match-type exact
set policy statement ARP_ND_SOURCE_MATCH ordinal 1 match rule 1 value arp-nd
set policy statement ARP_ND_SOURCE_MATCH ordinal 1 action
set policy statement ARP_ND_SOURCE_MATCH ordinal 1 action rule 1
set policy statement ARP_ND_SOURCE_MATCH ordinal 1 action rule 1 type community
set policy statement ARP_ND_SOURCE_MATCH ordinal 1 action rule 1 operation append
set policy statement ARP_ND_SOURCE_MATCH ordinal 1 action rule 1 value 111:111
set policy statement ARP_ND_SOURCE_MATCH ordinal 99
set policy statement ARP_ND_SOURCE_MATCH ordinal 99 action
set policy statement ARP_ND_SOURCE_MATCH ordinal 99 action rule 99
set policy statement ARP_ND_SOURCE_MATCH ordinal 99 action rule 99 operation
return-permit
```

```
{
  "rtbrick-config:statement": [
    {
      "name": "ARP_ND_SOURCE_MATCH",
      "ordinal": [
        {
          "ordinal": 1,
          "description": "ARP_ND_POLICY_SOURCE_COM_ADD",
          "match": {
            "rule": [
              {
                "rule": 1,
                "type": "source",
                "value-type": "discrete",
                "match-type": "exact",
                "value": [
                  "arp-nd"
                  ]
              }
            ]
          },
          "action": {
            "rule": [
              {
                "rule": 1,
                "type": "community",
                "operation": "append",
                "value": [
                  "111:111"
                  ]
              }
            ]
          }
        },
        {
          "ordinal": 99,
          "action": {
            "rule": [
              {
                "rule": 99,
                "operation": "return-permit"
              }
            ]
          }
        }
```

```
      ]
    }
  ]
}
```

2.9.3. Policy Operational Commands

Policy Test

You can use the policy test feature to test a policy before attaching it to a protocol or an instance.

Perform the following tasks:

- Step 1: Identify the brick daemon that will process the policy and the table to which the policy will be applied.
- Step 2: Execute the 'test policy run' command.

Example: Testing a BGP VPN export policy

```
supervisor@leaf1: op> test policy run bgp.appd.1 policy-name VPN_V4_EXPORT table
default.bgp.rib-in.import.ipv4.vpn-unicast
```

- Step 3: View the test results.

The policy test feature will create two result tables. The result table ending with ".policy.permit" will show all objects permitted by the policy, the one ending with ".policy.deny" will show all objects denied by the policy.

Example: Viewing the result tables

```
supervisor@leaf1: op> show datastore bgp.appd.1 table default.bgp.rib-
in.import.ipv4.vpn-unicast.policy.permit
<...>
supervisor@leaf1: op> show datastore bgp.appd.1 table default.bgp.rib-
in.import.ipv4.vpn-unicast.policy.deny
<...>
```

- Step 4: Clear the result tables

You can clear the result tables using the 'test policy clear' command. Apply the clear command to the same table for which you have run the policy test.

Example: Clearing the result tables

```
supervisor@leaf1: op> test policy clear bgp.appd.1 policy-name VPN_V4_EXPORT table
default.bgp.rib-in.import.ipv4.vpn-unicast
```

2.10. Static Routing

2.10.1. Static Routing Overview

Static routing allows a network administrator to configure routes manually. Using the RtBrick CLI, you can configure static IPv4, IPv6, MPLS, and multicast routes.

Guidelines and Limitations

- ECMP is not supported for static routes that include a null0 next-hop. If null0 is set as one of the next-hops, the system generates an error.
- An exit interface configuration is allowed in the case of null0, or the next hop must be link-local.

Supported Platforms

Not all features are necessarily supported on each hardware platform. Refer to the *Platform Guide* for the features and the sub-features that are or are not supported by each platform.

2.10.2. Static Routing Configuration

Configuration Hierarchy

The diagram illustrates the static routes configuration hierarchy.

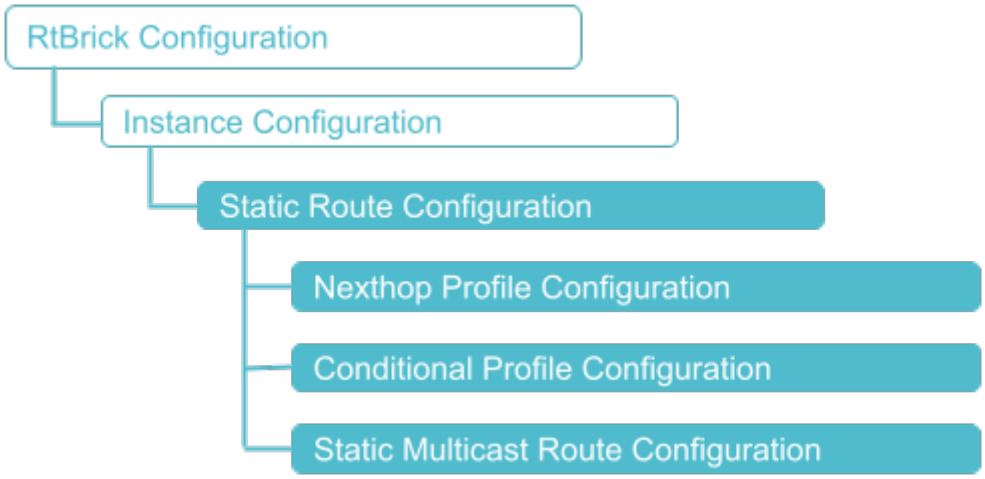


Figure 43. Static Route Configuration Hierarchy

Configuration Syntax and Commands

The following sections describe the static route configuration syntax and commands. In RBFS, next hops of static routes are configured separately, and referenced by the actual routes.

Static Route Configuration

This section describes how to configure the static route itself.

Syntax

```
set instance <instance-name> static route <attribute> <value>
```

Attribute	Description
<instance-name>	Name of the routing instance
<afi> <prefix | label> (true | false)	Supported AFIs are ipv4, ipv6, and mpls. In case of IPv4 or IPv6, configure the prefix. In case of MPLS, configure the incoming label and BOS flag.
<safi>	Supported SAFIs are unicast, labeled-unicast, and multicast.
<nexthop-profile>	Name of the nexthop profile
route-options no-install	This option keeps the routes in the routing information base, but prevents them from being used for forwarding traffic.

Example: Static Route Configuration

```
{
    "rtbrick-config:route": {
      "ipv4": [
        {
          "prefix4": "198.51.100.15/24",
          "safi": "unicast",
          "nexthop-profile": "nexthop1",
          "preference": 20

        }
      ],
      "ipv6": [
        {
          "prefix6": "2001:db8:0:117::/32",
          "safi": "unicast",
          "nexthop-profile": "nexthop2"
        }
      ],
      "mpls": [
        {
          "in-label": 8888,
          "in-bos": "true",
          "safi": "unicast",
          "nexthop-profile": "nexthop1"
        }
      ]
    }
  }
```

Example: Static Route Configuration with route-options no install

```
supervisor@rtbrick.net: cfg> show config instance default static route ipv4
192.1.0.6/32
{
  "rtbrick-config:ipv4": [
    {
      "prefix4": "192.1.0.6/32",
      "safi": "labeled-unicast",
      "nexthop-profile": "nh1",
      "route-options": "no-install"
    },
    {
      "prefix4": "192.1.0.6/32",
      "safi": "unicast",
      "nexthop-profile": "nh1"
    }
  ]
}
```

API To access the RESTCONF API that corresponds to this CLI, click here.

Nexthop Profile Configuration

You can group various nexthop parameters with a nexthop profile name and instance, and associate this nexthop profile with multiple routes.



A static route conditional profile check includes the route and its associated condition.

Syntax

set instance <instance-name> **static nexthop-profile** <name> <attribute> <value>

Attribute	Description
<instance-name>	Name of the routing instance
nexthop-profile <name>	Nexthop profile name
exit-interface <exit-interface>	Exit interface name
lookup-afi (ipv4 | ipv6 | mpls)	Lookup routing table address family where the nexthop will be resolved.
lookup-instance <lookup-instance>	Lookup routing table instance where the nexthop will be resolved.
lookup-safi (labeled-unicast | multicast | unicast)	Lookup routing table subsequent address family where the nexthop will be resolved.
nexthop <address>	IPv4/IPv6 nexthop address
out-bos (true | false)	Label BOS
out-label <out-label>	Label to be pushed
resolve-direct true	The option restricts all routes from resolving the nexthop of a static route instead, it allows only the direct routes to resolve the nexthop of a static route.

Example: Nexthop Profile Configuration

```
{
    "rtbrick-config:static": {
```

```
      "nexthop-profile": [
        {
          "name": "nexthop1",
          "nexthop": "198.51.100.145",
          "out-label": 4444
        },
        {
          "name": "nexthop3",
          "exit-interface": "ifp-0/0/4/4"
        }
      ]
    }
  }
```

- If you do not provide lookup-instance, lookup-afi and lookup-safi values, default values will be used to install the route.
- The exit interface attribute is mandatory for link-local nexthop.

API To access the RESTCONF API that corresponds to this CLI (IPv4 Nexthop Profile), click here.

API To access the RESTCONF API that corresponds to this CLI (IPv6 Nexthop Profile), click here.

Static Multicast Route Configuration

Syntax:

set instance <instance-name> **static route multicast4** <attribute> <value

Attribute	Description
<instance-name>	Name of the routing instance
<source>	IPv4 multicast source address
<group>	IPv4 multicast group address

Example: Static Multicast Route Configuration

```
{
    "rtbrick-config:static": {
      "route": {
        "multicast4": [
          {
            "source": "198.51.100.15/24",
            "group": "198.51.100.35/24",
            "nexthop-profile": "nexthop3"
          }
        ]
```

```
      }
    }
}
```

To access the RESTCONF API that corresponds to this CLI, click here.

Conditional Profile Configuration

By using the conditional static route feature, you can make specific routes conditional. These conditional routes are installed only if the specified condition is satisfied.

You can group various conditional parameters such as compare-operation, compare-type, compare-value, match-afi, match-instance, match-interface, match-isis-level, match-peer, and match-safi, and associate this conditional profile with multiple routes.

A static route conditional profile check includes the compare type and its associated attributes.

This feature is supported on the following Q2A and Q2C platforms:

- Edgecore CSR440 (AS7535-28XB)
- Edgecore AGR400 (AS7946-30XB)
- Edgecore AGR420 (AS7946-74XKSB)
- UfiSpace S9510-28DC
- UfiSpace S9600-32X
- UfiSpace S9600-72XC
- UfiSpace S9600-102XC

Configuring Conditional Profiles

Syntax:

set instance <instance-name> **static conditional-profile** <name> <attribute> <value>

Attribute	Description
conditional-profile <name>	Name of the conditional profile
compare-operation greater-than	Conditional routing compare operation
compare-type route-count	Conditional routing compare type The following compare types are supported: • any-isis-neighbor-up • bgp-peer-established • interface-up • isis-neighbor-up • route-count
compare-value <compare-value>	Conditional routing condition value
match-afi (ipv4 |ipv6 |mpls)	Routing tables address family (AFI) for which the condition will be checked.
match-instance <instance-name>	Routing instance where the condition will be checked.
match-interface <interface-name>	Interface name for which the condition will be checked.
match-isis-level <level-1 | level-2>	IS-IS level for which the condition will be checked.
match-peer <ipv4 | ipv6>	BGP peer for which the condition will be checked.
match-peer <ipv4 | ipv6> peer-address	BGP peer address for which the condition will be checked.
match-peer <ipv4 | ipv6> source-address	BGP source address for which the condition will be checked.
match-safi (labeled-unicast |multicast |unicast)	Routing table subsequent address family (SAFI) for which the condition will be checked.

Attribute	Description
nexthop-count	This option enables the static conditional policy logic to consider the number of next hops installed in the forwarding plane for static route install decisions.

Example 1: The following example configuration defines a conditional profile named backbone_v4 for the vrf1-blue instance, matching IPv4 unicast routes, and triggers when the route count exceeds 5. It specifies the matching criteria and comparison operation for static route conditions.

```
set instance vrf1-blue static conditional-profile backbone_v4
set instance vrf1-blue static conditional-profile backbone_v4 match-instance vrf1-
blue
set instance vrf1-blue static conditional-profile backbone_v4 match-afi ipv4
set instance vrf1-blue static conditional-profile backbone_v4 match-safi unicast
set instance vrf1-blue static conditional-profile backbone_v4 compare-type route-
count
set instance vrf1-blue static conditional-profile backbone_v4 compare-operation
greater-than
set instance vrf1-blue static conditional-profile backbone_v4 compare-value 5
```

```
{
  "rtbrick-config:conditional-profile": [
    {
      "name": "backbone_v4",
      "match-instance": "vrf1-blue",
      "match-afi": "ipv4",
      "match-safi": "unicast",
      "compare-type": "route-count",
      "compare-operation": "greater-than",
      "compare-value": 5
    }
  ]
}
```

Example 2: The following example configuration defines a conditional static routing profile named vrf1-blue_fabric_isis_link1 for the vrf1-blue instance, specifying that the static route is applied when the IS-IS neighbor on interface ifl-0/0/0/0 in the vrf1-blue instance is up. It uses the isis-neighbor-up condition to control route activation based on IS-IS neighbor status.

```
set instance vrf1-blue static conditional-profile vrf1-blue_fabric_isis_link1
set instance vrf1-blue static conditional-profile vrf1-blue_fabric_isis_link1
match-instance vrf1-blue
set instance vrf1-blue static conditional-profile vrf1-blue_fabric_isis_link1
compare-type isis-neighbor-up
set instance vrf1-blue static conditional-profile vrf1-blue_fabric_isis_link1
```

```
match-interface ifl-0/0/0/0
```

```
{
  "rtbrick-config:conditional-profile": [
    {
      "name": "vrf1-blue_fabric_isis_link1",
      "match-instance": "vrf1-blue",
      "compare-type": "isis-neighbor-up",
      "match-interface": "ifl-0/0/0/0"
    }
  ]
}
```

Example 3: The following example configuration defines a conditional static route profile named vrf1-blue_fabric_isis_l1 for the vrf1-blue routing instance, which activates when any IS-IS level-1 neighbor is up and matches the vrf1-blue instance.

```
set instance vrf1-blue static conditional-profile vrf1-blue_fabric_isis_l1
set instance vrf1-blue static conditional-profile vrf1-blue_fabric_isis_l1 match-
instance vrf1-blue
set instance vrf1-blue static conditional-profile vrf1-blue_fabric_isis_l1
compare-type any-isis-neighbor-up
set instance vrf1-blue static conditional-profile vrf1-blue_fabric_isis_l1 match-
isis-level level-1
```

```
{
  "rtbrick-config:conditional-profile": [
    {
      "name": "vrf1-blue_fabric_isis_l1",
      "match-instance": "vrf1-blue",
      "compare-type": "any-isis-neighbor-up",
      "match-isis-level": "level-1"
    }
  ]
}
```

Example 4: The following example configuration defines a static conditional profile named vrf1-blue_fabric_intf_link1 for the vrf1-blue instance, specifying that the profile applies when the vrf1-blue instance is matched and the interface ifl-0/0/0/0 is in the "up" state. It uses compare-type interface-up to trigger the condition based on the interface status.

```
set instance vrf1-blue static conditional-profile vrf1-blue_fabric_intf_link1
set instance vrf1-blue static conditional-profile vrf1-blue_fabric_intf_link1
match-instance vrf1-blue
set instance vrf1-blue static conditional-profile vrf1-blue_fabric_intf_link1
compare-type interface-up
set instance vrf1-blue static conditional-profile vrf1-blue_fabric_intf_link1
match-interface ifl-0/0/0/0
```

```
{
  "rtbrick-config:conditional-profile": [
    {
      "name": "vrf1-blue_fabric_intf_link1",
      "match-instance": "vrf1-blue",
      "compare-type": "interface-up",
      "match-interface": "ifl-0/0/0/0"
    }
  ]
}
```

Example 5: The following example configuration defines a static conditional profile named default_fabric_bgp_v4_198.51.100.1_peer within the default instance, specifying that it matches when a BGP peer session is established with the IPv4 peer at address 198.51.100.1 and source address 198.51.100.2. It sets the matching instance and compare type to ensure the profile applies only under these BGP session conditions.

```
set instance default static conditional-profile
default_fabric_bgp_v4_198.51.100.1_peer
set instance default static conditional-profile
default_fabric_bgp_v4_198.51.100.1_peer match-instance default
set instance default static conditional-profile
default_fabric_bgp_v4_198.51.100.1_peer compare-type bgp-peer-established
set instance default static conditional-profile
default_fabric_bgp_v4_198.51.100.1_peer match-peer ipv4 peer-address 198.51.100.1
set instance default static conditional-profile
default_fabric_bgp_v4_198.51.100.1_peer match-peer ipv4 source-address
198.51.100.2
```

```
{
  "rtbrick-config:conditional-profile": [
    {
      "name": "default_fabric_bgp_v4_198.51.100.1_peer",
      "match-instance": "default",
      "compare-type": "bgp-peer-established",
      "match-peer": {
        "ipv4": {
          "peer-address": "198.51.100.1",
          "source-address": "198.51.100.2"
        }
      }
    }
  ]
}
```

Example 6: The following example configuration defines a static conditional profile named default_fabric_bgp_v6_2001:db8::1_peer for the default instance, specifying that it matches when a BGP peer with IPv6 address 2001:db8::1 and source address 2001:db8::2 is established. It uses the bgp-peer-established compare type

to trigger actions based on the BGP session state.

```
set instance default static conditional-profile
default_fabric_bgp_v6_2001:db8::1_peer
set instance default static conditional-profile
default_fabric_bgp_v6_2001:db8::1_peer match-instance default
set instance default static conditional-profile
default_fabric_bgp_v6_2001:db8::1_peer compare-type bgp-peer-established
set instance default static conditional-profile
default_fabric_bgp_v6_2001:db8::1_peer match-peer ipv6 peer-address 2001:db8::1
set instance default static conditional-profile
default_fabric_bgp_v6_2001:db8::1_peer match-peer ipv6 source-address 2001:db8::2
```

```
{
  "rtbrick-config:conditional-profile": [
    {
      "name": "default_fabric_bgp_v6_2001:db8::1_peer",
      "match-instance": "default",
      "compare-type": "bgp-peer-established",
      "match-peer": {
        "ipv6": {
          "peer-address": "2001:db8::1",
          "source-address": "2001:db8::2"
        }
      }
    }
  ]
}
```

Example 7: The following example configuration defines a static conditional profile named default_fabric_bgp_v6_ll_link1_peer for the default instance, specifying that it matches the default instance, uses the bgp-peer-established compare type, and applies to the interface ifl-0/0/1/0. It is likely used to control routing or BGP behavior based on the state of a specific BGP peer on a particular interface.

```
set instance default static conditional-profile
default_fabric_bgp_v6_ll_link1_peer
set instance default static conditional-profile
default_fabric_bgp_v6_ll_link1_peer match-instance default
set instance default static conditional-profile
default_fabric_bgp_v6_ll_link1_peer compare-type bgp-peer-established
set instance default static conditional-profile
default_fabric_bgp_v6_ll_link1_peer match-interface ifl-0/0/1/0
```

```
{
  "rtbrick-config:conditional-profile": [
    {
      "name": "default_fabric_bgp_v6_ll_link1_peer",
      "match-instance": "default",
      "compare-type": "bgp-peer-established",
      "match-interface": "ifl-0/0/1/0"
```

```
    }
  ]
}
```

Example 8: The following example configuration defines a conditional profile named 'nexthop_count_ipv6'. It sets matching criteria based on address family (IPv6) and subsequent address family (unicast), and specifies that the profile triggers when the next-hop adjacency count is greater than 53.

```
set instance default static conditional-profile nexthop_count_ipv6
set instance default static conditional-profile nexthop_count_ipv6 match-afi ipv6
set instance default static conditional-profile nexthop_count_ipv6 match-safi
unicast
set instance default static conditional-profile nexthop_count_ipv6 compare-type
nexthop-count
set instance default static conditional-profile nexthop_count_ipv6 compare-
operation greater-than
set instance default static conditional-profile nexthop_count_ipv6 compare-value
53
```

```
{
  "rtbrick-config:conditional-profile": [
    {
      "name": "nexthop_count_ipv6",
      "match-afi": "ipv6",
      "match-safi": "unicast",
      "compare-type": "nexthop-count",
      "compare-operation": "greater-than",
      "compare-value": 53
    }
  ]
}
```

API To access the RESTCONF API that corresponds to this CLI, click here.

2.10.3. Static Routing Operational Commands

Show Commands

Static Routes Created by staticd

These commands show static routes as created by the static route daemon (staticd).

Syntax:

show static route <options>

Attribute	Description
<afi>	Supported AFIs are ipv4, ipv6, and mpls.
<safi>	Supported SAFIs are unicast, labeled-unicast, and multicast.
instance <name>	Static routes for an instance

Example: List static routes for all instances

```
supervisor@dev1: cfg> show static route
Instance: default, AFI: ipv4, SAFI: unicast
Prefix/Label              Pref    Next Hop                  Interface
198.51.100.100/24          2       198.51.100.22                -
Instance: default, AFI: ipv6, SAFI: unicast
Prefix/Label              Pref    Next Hop                  Interface
2001:db8:0:334::/32                2     2001:db8:0:99::                     -
```

Static Routes in the Routing Table

These commands show the static routes included in the final routing table.

Syntax:

show route <options> **source static** <options>

Attribute	Description
<afi>	Supported AFIs are ipv4, ipv6, and mpls.
<safi>	Supported SAFIs are unicast, labeled-unicast, and multicast.
detail	Detailed route information
instance <name>	Routing table information for a specific instance
label <value>	Destination label
mpls	Address family
prefix <value>	Destination prefix

Attribute	Description
source	Source of the routing information

Example 1: List static routes information

```
supervisor@dev1: cfg> show route ipv4 source static
Instance: default, AFI: ipv4, SAFI: unicast
Prefix/Label                            Source            Pref    Next Hop
Interface
198.51.100.100/24                        static            2       198.51.100.22
ifl-0/0/1/4
supervisor@dev1: cfg>
```

Example 2: List detailed static routes information

```
supervisor@dev1: cfg> show route ipv4 source static detail
Instance: default, AFI: ipv4, SAFI: unicast
198.51.100.100/24
  Source: static, Preference: 2
    Next Hop: 198.51.100.22
      Covering prefix: 198.51.100.22/24
      Next Hop type: direct, Next Hop action: None
      Resolved in: default-ipv4-unicast
      Egress interface: ifl-0/0/1/4, NextHop MAC: 7a:00:81:64:04:04
```

Example 3: List MPLS route information

```
supervisor@rtbrick: cfg> show route mpls
Instance: default, AFI: mpls, SAFI: unicast
Prefix/Label    Source            Pref    Next Hop                Interface
20010           bgp               170     2001:db8:0:110::        ifl-0/0/17/1001
20011           bgp               170     2001:db8:0:110::        ifl-0/0/17/1001
20012           bgp               170     2001:db8:0:110::        ifl-0/0/17/1001
20013           bgp               170     2001:db8:0:110::        ifl-0/0/17/1001
20014           bgp               170     2001:db8:0:110::        ifl-0/0/17/1001
20015           bgp               170     2001:db8:0:110::        ifl-0/0/17/1001
20016           bgp               170     2001:db8:0:110::        ifl-0/0/17/1001
20017           bgp               170     2001:db8:0:110::        ifl-0/0/17/1001
20018           bgp               170     2001:db8:0:110::        ifl-0/0/17/1001
```

3. Layer 2 Services

3.1. EVPN-VPWS

3.1.1. EVPN-VPWS Overview

Ethernet Virtual Private Network (EVPN) is a Layer 2 internetworking technology similar to BGP/MPLS IP VPN. EVPN uses extended BGP reachability information and advertisements between different Layer 2 networks at various sites in the control plane.

The EVPN Virtual Private Wire Service (VPWS) is a point-to-point (P2P) service that is built on the EVPN service architecture. EVPN-VPWS uses MPLS tunnels to traverse the backbone network. It offers a Layer 2 packet forwarding mode that connects access circuits (ACs) as per the specifications of RFC 8214.

Supported Standards

RFC Number	Description
7432	BGP MPLS-Based Ethernet VPN
8214	Virtual Private Wire Service Support in Ethernet VPN

EVPN VPWS Network Model

As shown in the figure below, an EVPN VPWS network contains the following building blocks:

- Customer edge (CE)—Customer device directly connected to the service provider network.
- Provider edge (PE)—Service provider device connected to CEs. PEs provide access to the EVPN VPWS network and forward traffic between customer network sites by using public tunnels.
- Attachment circuit (AC)—A physical or virtual link between a CE and a PE.
- Pseudowire (PW)—A virtual bidirectional connection between two PEs. A PW comprises a pair of virtual links in opposite directions.
- MPLS transport tunnel—A connection that carries one or more PWs across the

MPLS core or IP backbone, such as an MPLS tunnel.

- Cross-connect—A connection formed by two physical or virtual circuits, such as ACs and PWs, that switches packets between them.

The figure below shows the protocol packet exchange process in the EVPN VPWS.

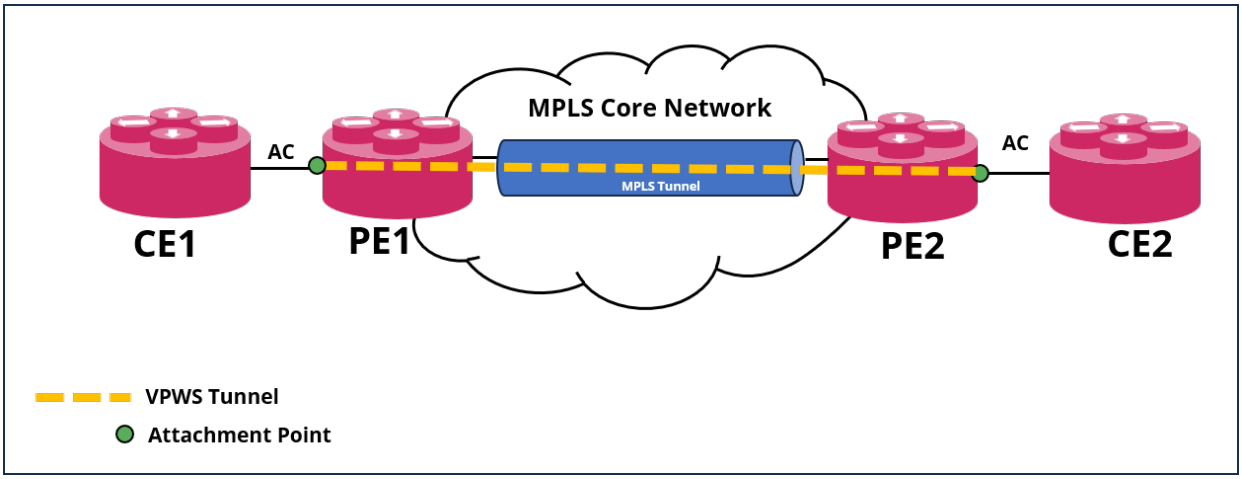


Figure 44. Protocol Packet Exchange Process in EVPN VPWS

PE1 and PE2 are each configured with an EVPN VPWS instance. After the PE receives packets from the AC, it adds the PW label and sends them to the peer PE through the MPLS label-switched path (LSP). After the other PE (PE2) receives the packet via the MPLS LSP, it pops the PW label of the packets and forwards the packets to the AC bound to the PW.

VLAN Tag Manipulation

VLAN Tag Manipulation involve modifying VLAN tags on Ethernet frames to ensure proper traffic segmentation and delivery across a Layer 2 network. RBFS supports some VLAN Tag Manipulation operations which are used to manipulate tags on Ethernet frames as they enter or leave a network interface. These manipulations include adding, removing, and rewriting VLAN tags. VLAN manipulation operations can be performed both at ingress and egress nodes.

The following VLAN manipulation operations are supported for Layer 2 VPN interfaces:

- **push**: Adds a single outer VLAN tag to an Ethernet frame.
- **pop**: Removes a single outer VLAN tag from an Ethernet tag frame.
- **swap**: Rewrite a single outer VLAN tag of an Ethernet tag frame.

- **push–push**: Adds two VLAN tags to an Ethernet frame.
- **pop-pop**: Removes two VLAN tags from an Ethernet tags frame.
- **swap–swap**: Rewrite both the outer and inner VLAN tags of an Ethernet tags frame.
- **swap–push**: Rewrite the outer VLAN tag and add a new inner VLAN tag for Ethernet tags' frame.
- **pop–swap**: Removes the outer VLAN tag and rewrites the inner VLAN tag of an Ethernet tags' frame.

Supported CLI Options for VLAN Tag Manipulation Operations

The following table presents the various VLAN tag manipulation operations and supported CLI options.

CLI Options	pop	push	swap	push-push	pop-pop	swap-push	swap-swap	pop-swap
vlan-id	No	Yes	Yes	Yes	No	Yes	Yes	Yes
vlan-encapsulation	No	Yes	Yes	Yes	No	Yes	Yes	Yes
innervlan-id	No	No	No	Yes	No	Yes	Yes	No

Supported Platforms

Not all features are necessarily supported on each hardware platform. Refer to the *Platform Guide* for the features and the sub-features that are or are not supported by each platform.



Currently, the following features are not supported for EVPN VPWS:

- Policy filtering options (at Address Family/Peer-Group/Instance levels)
- LAG interface as an attachment circuit
- LAG interface as an LSP MPLS path
- Route Reflection
- Add-Path
- VLAN change configuration on L2 IFL

3.1.2. EVPN VPWS Configuration

Configuration Hierarchy

The diagram illustrates the EVPN-VPWS configuration hierarchy. All EVPN VPWS configurations are done within an instance, such as the default instance or an EVPN service instance.

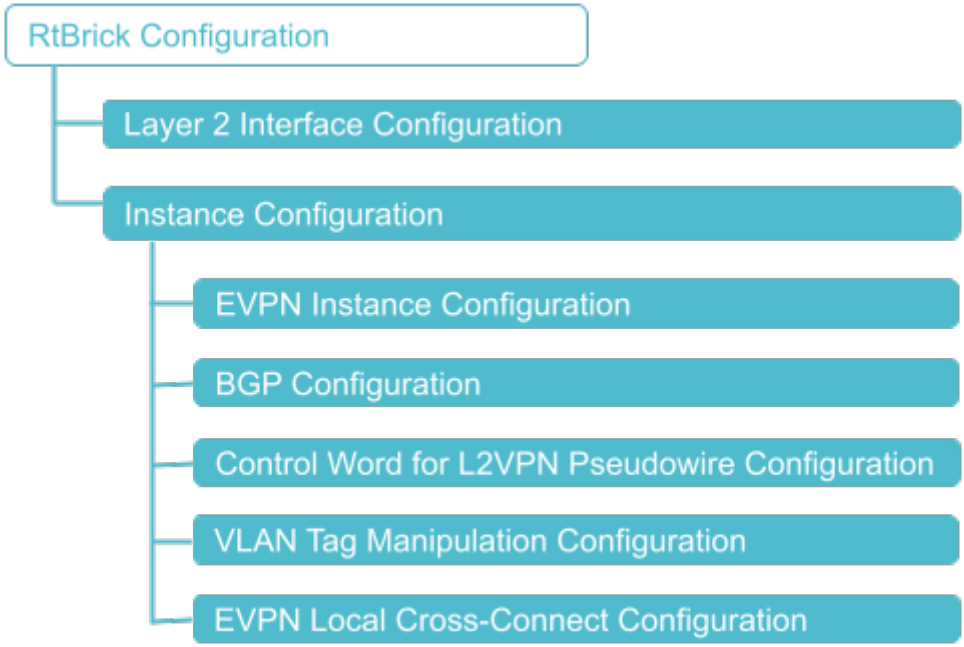


Figure 45. EVPN VPWS Configuration Hierarchy

Configuration Syntax and Commands

The following sections describe the EVPN-VPWS configuration syntax and commands.

Layer 2 Interface Configuration

EVPN-VPWS supports the configuration of Layer 2 logical interfaces.

Syntax:

```
set interface <name> <attribute> <value>
```

Attribute	Description
<name>	Specify the name of the interface. Example: ifp-0/0/1.
unit <unit-id>	Create a logical interface (also referred to as a sub-interface) under the physical interface
unit <unit-id> interface-type l2vpn-vpws	Specify the type of the L2VPN interface.
unit <unit-id> match-type port	Sets the "port" match-type for the L2VPN VPWS untagged interfaces. For tagged interfaces, "port" match-type is not supported. Ensure that there are no other tagged configurations for the interfaces when the port match-type is configured. When port matching is configured, it will match all traffic regardless of whether it is untagged, single-tagged, or double-tagged VLANs.
unit <unit-id> vlan <outer-vlan-id>	Outer VLAN ID.
unit <unit-id> vlan <inner-vlan-id>	Inner VLAN ID.
unit <unit-id> instance <instance>	Assign the logical interface to an instance.

The following example shows an untagged interface configuration along with "port" match-type for the L2VPN VPWS untagged interface.

```
set interface ifp-0/0/17 unit 0
set interface ifp-0/0/17 unit 0 interface-type l2vpn-vpws
set interface ifp-0/0/17 unit 0 match-type port
set interface ifp-0/0/17 unit 0 instance evpn-vpws-vrf1
commit
```

The following example shows a single-tagged interface configuration.

```
set interface ifp-0/0/17 unit 100
set interface ifp-0/0/17 unit 100 interface-type l2vpn-vpws
set interface ifp-0/0/17 unit 100 instance evpn-vpws-vrf2
set interface ifp-0/0/17 unit 100 vlan 100
commit
```

The following example shows a double-tagged interface configuration.

```
set interface ifp-0/0/17 unit 200
set interface ifp-0/0/17 unit 200 interface-type l2vpn-vpws
set interface ifp-0/0/17 unit 200 instance evpn-vpws-vrf3
set interface ifp-0/0/17 unit 200 vlan 200
set interface ifp-0/0/17 unit 200 inner-vlan 201
commit
```

EVPN Instance Configuration

An EVPN Instance (EVI) is a routing and forwarding instance of EVPN that covers all the participating PE routers in a VPN. EVI is configured per customer on the PE routers. Each EVI has a unique route distinguisher and one or more route targets.

Syntax:

set instance <name> <attribute> <value>

Attribute	Description
<name>	A unique name for the EVPN routing instance.
address-family <afi>	Address family identifier (AFI). Supported value: l2vpn
address-family <afi> <safi>	Subsequent address family identifier (SAFI). Supported values: evpn-vpws evpn-vpws needs to be enabled on the VRF instance.
protocol	Specifies the routing protocol
route-distinguisher as-number | ipv4-address:id>	The route distinguisher (RD) uniquely defines routes within an IPv4 network. PE routers use route distinguishers to identify which VPN a packet belongs to. Supported formats are <as-number:id> or <ipv4-address:id>.
ipv4-router-id <ipv4-router-id>	The router ID of the routing instance.

Attribute	Description
route-target (import | export) <rt-value>	Route targets (RT) are used to transfer routes between VPN instances. The RT identifies a subset of routes that should be imported to or exported from a particular VPN instance. You can configure an RT for importing or exporting routes or both.

In the following configuration, VRF instance AFI has been set to AFI: l2vpn and SAFI: evpn-vpws.

```
set instance evpn-vpws-vrf1
set instance evpn-vpws-vrf1 ipv4-router-id 192.1.6.3
set instance evpn-vpws-vrf1 route-distinguisher 192.1.6.3:65006
set instance evpn-vpws-vrf1 address-family l2vpn evpn-vpws
set instance evpn-vpws-vrf1 address-family l2vpn evpn-vpws route-target import
target:192.1.6.0:65006
set instance evpn-vpws-vrf1 address-family l2vpn evpn-vpws route-target export
target:192.1.6.0:65006
commit
```

BGP Configuration

BGP L2VPN VFT (Virtual Forwarding Table) Configuration

Syntax:

set instance <name> **protocol bgp** <attribute> <value>

Attribute	Description
<name>	Name of the routing instance
address-family <afi>	Address family identifier (AFI). Supported value: l2vpn
address-family <afi> <safi>	Subsequent address family identifier (SAFI). Supported value: evpn-vpws  evpn-vpws needs to be enabled on the VRF instance.
local-as <as-number>	The AS number in four-byte format. The numbers allowed are from 1 to 4294967295.
interface <name>	Interface that is bound to L2VPN

Attribute	Description
interface <name> local-service-id <local-service-id>	Specify the local service ID that is used to establish an EVPN PW between two PEs
interface <name> remote-service-id <remote-service-id>	Specify the remote service ID that is used to establish an EVPN PW between two PEs

The following example configures evpn-vpws-vrf1 instance for BGP L2VPN.

```
set instance evpn-vpws-vrf1 protocol bgp local-as 65006
set instance evpn-vpws-vrf1 protocol bgp address-family l2vpn evpn-vpws
set instance evpn-vpws-vrf1 protocol bgp address-family l2vpn evpn-vpws interface
ifl-0/0/17/0
set instance evpn-vpws-vrf1 protocol bgp address-family l2vpn evpn-vpws interface
ifl-0/0/17/0 local-service-id 100
set instance evpn-vpws-vrf1 protocol bgp address-family l2vpn evpn-vpws interface
ifl-0/0/17/0 remote-service-id 101
commit
```

BGP L2VPN EVPN Configuration

Configuring the BGP L2VPN EVPN Address Family

Syntax:

set instance <name> **protocol bgp address-family l2vpn evpn**

Attribute	Description
<name>	Name of the routing instance

To configure BGP L2VPN EVPN on the default instance, enter the following command:

```
set instance default protocol bgp address-family l2vpn evpn
commit
```

Configuring Address Families for Peer Groups

Syntax:

set instance <instance-name> **protocol bgp peer-group** <pg-name> **address-family** <afi> <safi> <attribute> <value>

Attribute	Description
<afi>	Address family identifier (AFI). Supported value: l2vpn.
<safi>	Subsequent address family identifier (SAFI). Supported value: evpn
extended-nexthop	Enable extended-next-hop encoding for BGP peer groups to allow the transfer of IPv4 prefixes over an IPv6 connection.
update-nexthop (ipv4-address | ipv6-address) <address>	BGP nexthop address for routes advertised to this peer group

To configure BGP L2VPN Peer Group on the default instance, enter the following command:

```
set instance default protocol bgp peer-group spine address-family l2vpn evpn
commit
```

Configuring Control Word for L2VPN Pseudowire

In a network with EVPN-VPWS service, a control word can be inserted between the label stack and the MPLS payload. Control word is disabled by default.

Syntax:

set instance <name> **protocol bgp address-family l2vpn evpn-vpws interface** <interface> **control-word enable**

Attribute	Description
<name>	Name of the routing instance.
<interface>	Name of the interface.

To enable Control Word on the default instance, enter the following command:

```
set instance default protocol bgp peer-group spine address-family l2vpn evpn-vpws
interface ifl-0/0/1/10 control-word enable
commit
```

Configuring VLAN Tag Manipulation

The following section describes the VLAN tag manipulation configuration syntax and commands.

Syntax:

set interface <interface-name> **unit** <unit id> **[input-vlan-map** | **output-vlan-map]** <attribute> <value>

Attribute	Description
<name>	Specify the name of the interface.
unit <unit-id>	Specify the unit ID for the interface.
unit <unit-id> input-vlan-map	Ingress VLAN mapping.
unit <unit-id> output-vlan-map	Egress VLAN mapping
vlan-operation	Specify any of the VLAN operations supported: pop, pop-pop, pop-swap, push, push-push, swap, swap-push, and swap-swap.
vlan-encapsulation	Specify the encapsulation type for the VLAN operation. Supported only 802.1q.
vlan-id	Specify the outer VLAN for the VLAN operation specified.
inner-vlan-id	Specify the inner VLAN for the VLAN operation specified.

Example for VLAN 'push' operation configuration

```
supervisor@rtbrick.net: cfg> show config set interface ifp-0/1/4 unit 1000
set interface ifp-0/1/4 unit 1000
set interface ifp-0/1/4 unit 1000 interface-type l2vpn-vpws
set interface ifp-0/1/4 unit 1000 output-vlan-map vlan-operation push
```

```
set interface ifp-0/1/4 unit 1000 output-vlan-map vlan-id 1001
set interface ifp-0/1/4 unit 1000 instance vrf2-evpn-vpws
set interface ifp-0/1/4 unit 1000 vlan 1000
```

Example: VLAN 'push' operation configuration.

```
supervisor@rtbrick.net: cfg> show config interface ifp-0/1/4 unit 1000
{
  "rtbrick-config:unit": [
    {
      "unit-id": 1000,
      "interface-type": "l2vpn-vpws",
      "output-vlan-map": {
        "vlan-operation": "push",
        "vlan-id": 1001
      },
      "instance": "vrf2-evpn-vpws",
      "vlan": 1000
    }
  ]
}
```

Configuring EVPN Local Cross-Connect

Local cross-connect is a special case of VPWS in which local and remote sites are connected to the same router. When the VPWS configuration is received, BGP checks if the exact remote site is locally configured. If so, BGP understands it needs to perform a local cross-connect. Local cross-connect for the local site and remote site and vice versa should be configured on the same VRF instance.

The following example shows a single-tagged interface configuration for the VRF instance (evpn-vpws-vrf1).

```
set interface ifp-0/0/17 unit 0
set interface ifp-0/0/17 unit 0 interface-type l2vpn-vpws
set interface ifp-0/0/17 unit 0 instance evpn-vpws-vrf1
set interface ifp-0/0/17 unit 0 vlan 100
set interface ifp-0/0/17 unit 10
set interface ifp-0/0/17 unit 10 interface-type l2vpn-vpws
set interface ifp-0/0/17 unit 10 instance evpn-vpws-vrf1
set interface ifp-0/0/17 unit 10 vlan 100
commit
```

The following examples show the local cross-connect configurations for the same VRF instance (evpn-vpws-vrf1).

```
set instance evpn-vpws-vrf1 protocol bgp local-as 65006
set instance evpn-vpws-vrf1 protocol bgp address-family l2vpn evpn-vpws
set instance evpn-vpws-vrf1 protocol bgp address-family l2vpn evpn-vpws interface
```

```
ifl-0/0/17/0
set instance evpn-vpws-vrf1 protocol bgp address-family l2vpn evpn-vpws interface
ifl-0/0/17/0 local-service-id 100
set instance evpn-vpws-vrf1 protocol bgp address-family l2vpn evpn-vpws interface
ifl-0/0/17/0 remote-service-id 101
commit
```

```
set instance evpn-vpws-vrf1 protocol bgp local-as 65006
set instance evpn-vpws-vrf1 protocol bgp address-family l2vpn evpn-vpws
set instance evpn-vpws-vrf1 protocol bgp address-family l2vpn evpn-vpws interface
ifl-0/0/17/10
set instance evpn-vpws-vrf1 protocol bgp address-family l2vpn evpn-vpws interface
ifl-0/0/17/10 local-service-id 101
set instance evpn-vpws-vrf1 protocol bgp address-family l2vpn evpn-vpws interface
ifl-0/0/17/10 remote-service-id 100
commit
```

3.1.3. EVPN VPWS Operational Commands

EVPN VPWS Show Commands

The following show commands display the EVPN VPWS-related information.

BGP Summary

This command displays BGP protocol parameters like attributes or timers that are generic to the BGP instance.

Syntax:

show bgp summary <option>

Attribute	Description
Option	Description
-	Without any option, the command displays the information for all instances.
instance <instance-name>	BGP summary information for the given instance.

Example: BGP summary for instance evpn-vpws-vrf1

```
supervisor@rtbrick: op> show bgp summary instance evpn-vpws-vrf1
Instance: evpn-vpws-vrf1
```

```
  General information
    Hostname: , Domain name:
    Local AS: 65006, Version: 4
    Local preference: 100, eBGP Protocol preference: 20, iBGP Protocol preference:
200
    Router ID: 192.168.6.10, Cluster ID: 192.168.6.10
  Capabilities
    Route refresh: True, AS4: True, Graceful restart: False, L2VPN EVPN-VPWS:True
  Best route selection
    Always compare MED: False, Ignore as path: False
    Ignore local preference: False, Ignore origin: False
    Ignore MED: False, Ignore route source: False
    Ignore router ID: False, Ignore uptime: True
    Ignore cluster length: False, Ignore peer IP: False
    Route select parameter: 0
  Timers
    Connect retry: 30s, Keepalive: 30s, Holdtime: 90s
  Statistics
    Peers configured: 0, Peers auto discovery: 0
      Peers in idle          : 0
      Peers in connect       : 0
      Peers in active        : 0
      Peers in opensent      : 0
      Peers in openconfirm   : 0
      Peers in established   : 0
```

BGP Peer

The 'show bgp peer' commands display information on BGP peers.

Syntax:

show bgp peer <option>

Option	Description
-	Without any option, the commands display all BGP peers in all instances in a summary table format.
detail	Detailed information on all BGP peers in all instances in a list view.
<peer-name>	Detailed information on the peer with the given name.
address <peer-address>	Detailed information on the peer with the given IP address.
history	Displays BGP peer history information such as the peer state down reasons.

Option	Description
history <peer-address>	Displays BGP peer history information such as the peer state down reasons for a specified peer.
instance <instance-name>	Summary of all BGP peers in the given instance.
instance <instance-name> detail	Detailed information on all BGP peers in the given instance.
instance <instance-name> detail <peer-name>	Detailed information on the peer with the given name in the given instance.
instance <instance-name> detail address <peer-address>	Detailed information on the peer with the given IP address in the given instance.
statistics	Received and sent BGP prefixes per AFI/SAFI for all peers in all instances.
statistics peer <peer-name>	Received and sent BGP prefixes per AFI/SAFI for the peer with the given name.
statistics peer address <peer-address>	Received and sent BGP prefixes per AFI/SAFI for the peer with the given IP address.
statistics instance <instance-name> peer <peer-name>	Received and sent BGP prefixes per AFI/SAFI for the peer with the given name in the given instance.
statistics instance <instance-name> peer address <peer-address>	Received and sent BGP prefixes per AFI/SAFI for the peer with the given IP address in the given instance.

Example 1: BGP Peer Information for instance default

```
supervisor@rtbrick: op> show bgp peer instance default
Instance: default
  Peer     Remote AS    State         Up/Down Time    PfxRcvd         PfxSent
  spine1   4200000000   Established   0d:00h:42m:53s  5               14
```

Example 2: Detailed view of BGP Peer Information

```
supervisor@rtbrick: op> show bgp peer detail
Peer: spine1, Peer IP: fe80::9a19:2cff:fe99:4701, Remote AS: 4200000000, Local:
fe80::9a19:2cff:fe36:3e03, Local AS: 4200000004, Any AS: False
  Type: ebgp, State: Established, Up/Down Time: 0d:01h:00m:40s
  Discovered on interface: ifl-0/0/2/1
```

```
  Last transition: Thu Apr 18 04:50:56 GMT +0000 2024, Flap count: 0
  Peer ID        : 192.1.0.1, Local ID  : 192.1.0.4
  Instance       : default, Peer group: spine
  6PE enabled    : False
  Timer values:
    Peer keepalive : 30s, Local keepalive: 30s
    Peer holddown  : 90s, Local holddown : 90s
    Connect retry  : 30s
  Timers:
    Connect retry timer : 0s
    Keepalive timer     : expires in 21s 796304us
    Holddown timer      : expires in 1m 13s 560627us
  NLRIs:
    Sent           : ['l2vpn-evpn', 'ipv4-unicast', 'ipv6-unicast', 'ipv4-vpn-
unicast', 'ipv6-vpn-unicast', 'ipv4-vpn-multicast', 'l2vpn-vpls', 'ipv4-labeled-
unicast', 'ipv6-labeled-unicast']
    Received       : ['l2vpn-evpn', 'ipv4-unicast', 'ipv6-unicast', 'ipv4-vpn-
unicast', 'ipv6-vpn-unicast', 'ipv4-vpn-multicast', 'l2vpn-vpls', 'ipv4-labeled-
unicast', 'ipv6-labeled-unicast']
    Negotiated     : ['l2vpn-evpn', 'ipv4-unicast', 'ipv6-unicast', 'ipv4-vpn-
unicast', 'ipv6-vpn-unicast', 'ipv4-vpn-multicast', 'l2vpn-vpls', 'ipv4-labeled-
unicast', 'ipv6-labeled-unicast']
  Capabilities:
    Addpath sent                  : None
    Addpath received              : None
    Addpath negotiated            : None
    Extended nexthop sent         : ['ipv4-unicast', 'ipv4-vpn-unicast', 'ipv4-
vpn-multicast', 'ipv4-labeled-unicast']
    Extended nexthop received     : ['ipv4-unicast', 'ipv4-labeled-unicast',
'ipv4-vpn-multicast', 'ipv4-vpn-unicast']
    Extended nexthop negotiated   : ['ipv4-unicast', 'ipv4-labeled-unicast',
'ipv4-vpn-multicast', 'ipv4-vpn-unicast']
    Capabilities:
      Feature                     Sent            Received        Negotiated
      Route refresh               True            True            True
      4 byte AS                   True            True            True
      Graceful restart            False           False           False
      Link local only             False           False           False
  Prefix Limit:
  End of RIB:
    Address family               Sent                                Received
    IPv4 unicast                 Thu Apr 18 04:50:59 GMT +0000 2024  Thu Apr 18
04:50:59 GMT +0000 2024
    IPv4 labeled-unicast         Thu Apr 18 04:50:59 GMT +0000 2024  Thu Apr 18
04:50:59 GMT +0000 2024
    IPv6 unicast                 Thu Apr 18 04:50:59 GMT +0000 2024  Thu Apr 18
04:50:59 GMT +0000 2024
    IPv6 labeled-unicast         Thu Apr 18 04:50:59 GMT +0000 2024  Thu Apr 18
04:50:59 GMT +0000 2024
    IPv4 VPN-unicast             Thu Apr 18 04:50:59 GMT +0000 2024  Thu Apr 18
04:50:59 GMT +0000 2024
    IPv6 VPN-unicast             Thu Apr 18 04:50:59 GMT +0000 2024  Thu Apr 18
04:50:59 GMT +0000 2024
    IPv4 VPN-multicast           Thu Apr 18 04:50:59 GMT +0000 2024  Thu Apr 18
04:50:59 GMT +0000 2024
    L2VPN VPLS                   Thu Apr 18 04:50:59 GMT +0000 2024  Thu Apr 18
04:50:59 GMT +0000 2024
    L2VPN EVPN                   Thu Apr 18 04:50:59 GMT +0000 2024  Thu Apr 18
04:50:59 GMT +0000 2024
  Message stats:
    Session stats:
```

```
      Direction   Open         Update       Keepalive    Notify       Route
refresh
      Input       0            0            72           0            0
      Output      0            0            71           0            0
    Total stats:
      Input       0            0            72           0            0
      Output      0            0            71           0            0
    Route stats:
      Address family                 Received     Sent         Prefix limit Idle
timeout
      IPv4 unicast                   0            0            0            0
      IPv4 labeled-unicast           0            0            0            0
      IPv6 unicast                   0            0            0            0
      IPv6 labeled-unicast           0            0            0            0
      IPv4 VPN-unicast               0            0            0            0
      IPv6 VPN-unicast               0            0            0            0
      IPv4 VPN-multicast             0            0            0            0
      L2VPN VPLS                     0            0            0            0
      L2VPN EVPN                     0            0            0            0
<...>
```

Example 3: BGP Peer Statistics for a specific peer

```
supervisor@rtbrick: op> show bgp peer statistics peer address
fe80::781a:c6ff:fec0:1
Instance: default
  Peer                           AFI     SAFI               PfxRcvd    PfxSent
  spine1                         ipv4    unicast            0          0
                                 ipv4    labeled-unicast    0          0
                                 ipv6    unicast            1          4
                                 ipv6    labeled-unicast    1          4
                                 ipv4    vpn-unicast        0          0
                                 ipv6    vpn-unicast        0          0
                                 ipv4    multicast          0          0
                                 ipv4    vpn-multicast      0          0
                                 l2vpn   evpn               3          6
```

Example 4: BGP Peer history for a specified peer

```
supervisor@rtbrick.net: op> show bgp peer history peer address 192:168::40
Instance: vrf1
  Peer Address               Source Address             Type             Last
Reset Reason
  192:168::40                192:168:5::20              FSM Error        FSM
Error, Sub-Code: Unexpected message in OpenSent State
```

BGP RIB-in

This command displays the received routes.

Syntax:

show bgp rib-in <option>

Option	Description
-	Without any option, the command displays information on the received BGP routing table on all instances in a summary table format.
<afi>	BGP routing table summary for the given address family (AFI), all sub-address families and all instances. Supported AFI values are 'ipv4', 'ipv6' and l2vpn.
<afi> <safi>	BGP routing table summary for the given address family (AFI) and sub-address family (SAFI), and all instances. Supported SAFI values are evpn, 'labeled-unicast', 'unicast', 'vpn-multicast', 'vpn-unicast', and evpn-vpws.
<afi> <safi> detail	Detailed list view of the BGP routing table for the given address family (AFI) and sub-address family (SAFI), and all instances.
<afi> <safi> <prefix>	BGP routing table entry for the given prefix and all instances.
<afi> <safi> instance <instance-name>	BGP routing table summary for the given AFI, SAFI, and instance.
<afi> <safi> instance <instance-name> detail	Detailed list view of BGP routing table for the given AFI, SAFI, and instance.
<afi> <safi> instance <instance-name> <prefix>	BGP routing table entry for the given prefix and instance.
<afi> <safi> community <community-name>	BGP community details for the given AFI, SAFI, and instance.
<afi> <safi> error	BGP route with error status for the given AFI, SAFI, and instance.
<afi> <safi> peer <name> / peer address <ip>	Peer name or address

Example 1: Summary view of the BGP rib-in where you can find received information for the EVPN VPWS instances like evpn-vpws-vrf1, evpn-vpws-vrf2, and

evpn-vpws-vrf3.

```
supervisor@rtbrick: op> show bgp rib-in
Flags: & - Imported, ! - Error
Instance: default, AFI: ipv6, SAFI: unicast
  Hostname: Local, Peer IP: 0.0.0.0
  Source IP: 0.0.0.0, Total routes: 3
    Prefix                                    Next Hop                          MED        Lpref
AS Path    Status
    192:1::3/128                                                                0          100
-          Valid
    192:1::5/128                                                                0          100
-          Valid
    192:1::6/128                                                                0          100
-          Valid
  Hostname: spine1, Peer IP: fe80::781a:c6ff:fec0:1
  Source IP: fe80::7857:d6ff:fec0:0, Total routes: 1
    Prefix                                    Next Hop                          MED        Lpref
AS Path    Status
    192:1::1/128                              fe80::781a:c6ff:fec0:1            0          -
4200000000 Valid
Instance: default, AFI: ipv6, SAFI: labeled-unicast
  Hostname: Local, Peer IP: 0.0.0.0
  Source IP: 0.0.0.0, Total routes: 3
    Prefix                                    Next Hop                          MED        Lpref
AS Path    Status
    192:1::3/128                                                                0          100
-          Valid
    192:1::5/128                                                                0          100
-          Valid
    192:1::6/128                                                                0          100
-          Valid
  Hostname: spine1, Peer IP: fe80::781a:c6ff:fec0:1
  Source IP: fe80::7857:d6ff:fec0:0, Total routes: 1
    Prefix                                    Next Hop                          MED        Lpref
AS Path    Status
    192:1::1/128                              fe80::781a:c6ff:fec0:1            0          -
4200000000 Valid
Instance: evpn-vpws-vrf1, AFI: l2vpn, SAFI: evpn-vpws
  Hostname: Local, Peer IP: 0.0.0.0
  Source IP: 0.0.0.0, Total routes: 1
    Prefix                                    Next Hop                          MED        Lpref
AS Path    Status
    00.00.00.00.00.00.00.00.00.00:100/112                                       0          100
-          Valid
Instance: evpn-vpws-vrf2, AFI: l2vpn, SAFI: evpn-vpws
  Hostname: Local, Peer IP: 0.0.0.0
  Source IP: 0.0.0.0, Total routes: 1
    Prefix                                    Next Hop                          MED        Lpref
AS Path    Status
    00.00.00.00.00.00.00.00.00.00:110/112                                       0          100
-          Valid
Instance: evpn-vpws-vrf3, AFI: l2vpn, SAFI: evpn-vpws
  Hostname: Local, Peer IP: 0.0.0.0
  Source IP: 0.0.0.0, Total routes: 1
    Prefix                                    Next Hop                          MED        Lpref
AS Path    Status
    00.00.00.00.00.00.00.00.00.00:200/112                                       0          100
-          Valid
Instance: default, AFI: l2vpn, SAFI: evpn
  Hostname: spine1, Peer IP: fe80::781a:c6ff:fec0:1
  Source IP: fe80::7857:d6ff:fec0:0, Total routes: 3
    Prefix                                    Next Hop                          MED        Lpref
AS Path    Status
    00.00.00.00.00.00.00.00.00.00:101/112     192:1::1                          0          -
4200000000 Valid
    00.00.00.00.00.00.00.00.00.00:111/112     192:1::1                          0          -
4200000000 Valid
    00.00.00.00.00.00.00.00.00.00:201/112     192:1::1                          0          -
4200000000 Valid
```

Example 2: Summary view of the BGP rib-in where you can find received

information for address family l2vpn vpws.

```
supervisor@rtbrick: op> show bgp rib-in l2vpn evpn
Flags: & - Imported, ! - Error
Instance: default, AFI: l2vpn, SAFI: evpn
 Hostname: spine1, Peer IP: fe80::9a19:2cff:fe99:4701, Source IP: fe80::9a19:2cff:fe36:3e03, Total routes: 3
    Prefix                                      Next Hop                          MED        Lpref
AS Path    Status
    00.00.00.00.00.00.00.00.00.00:101/112       192:1::1                          0          -
4200000000, 4200000003 Valid
    00.00.00.00.00.00.00.00.00.00:111/112       192:1::1                          0          -
4200000000, 4200000003 Valid
    00.00.00.00.00.00.00.00.00.00:201/112       192:1::1                          0          -
4200000000, 4200000003 Valid
```

BGP FIB

The 'show bgp fib' commands display the BGP forwarding table.

Syntax:

show bgp fib <option>

Option	Description
-	Without any option, the commands display the BGP forwarding table for all address families and all instances in a summary table format.
<afi>	BGP forwarding table summary for the given address family (AFI), all sub-address families and all instances. Supported AFI values are l2vpn, 'ipv4' and 'ipv6'.
<afi> <safi>	BGP forwarding table summary for the given address family (AFI) and sub-address family (SAFI), and all instances. Supported SAFI values are 'unicast', 'labeled-unicast', 'vpn-multicast', 'vpn-unicast', and evpn-vpws.
<afi> <safi> detail	Detailed list view of the BGP forwarding table for the given address family (AFI) and sub-address family (SAFI), and all instances.
<afi> <safi> <prefix>	BGP forwarding table entry for the given prefix and all instances.

Option	Description
<afi> <safi> instance <instance-name>	BGP forwarding table summary for the given AFI, SAFI, and instance.
<afi> <safi> instance <instance-name> detail	Detailed list view of BGP forwarding table for the given AFI, SAFI, and instance.
<afi> <safi> instance <instance-name> <prefix>	BGP forwarding table entry for the given prefix and instance.

Example: Summary view of the BGP FIB

```
supervisor@rtbrick: op> show bgp fib
Instance: default, AFI: ipv6, SAFI: unicast
  Prefix                                    Preference      Out Label           Next Hop
  192:1::1/128                              20              -                   fe80::781a:c6ff:fec0:1
Instance: default, AFI: ipv6, SAFI: labeled-unicast
  Prefix                                    Preference      Out Label           Next Hop
  192:1::1/128                              20              -                   fe80::781a:c6ff:fec0:1
Instance: evpn-vpws-vrf1, AFI: l2vpn, SAFI: evpn-vpws
  Prefix                                    Preference      Out Label           Next Hop
  00.00.00.00.00.00.00.00.00.00:101/112     20              20004,bos:1         192:1::1
Instance: evpn-vpws-vrf2, AFI: l2vpn, SAFI: evpn-vpws
  Prefix                                    Preference      Out Label           Next Hop
  00.00.00.00.00.00.00.00.00.00:111/112     20              20005,bos:1         192:1::1
Instance: evpn-vpws-vrf3, AFI: l2vpn, SAFI: evpn-vpws
  Prefix                                    Preference      Out Label           Next Hop
  00.00.00.00.00.00.00.00.00.00:201/112     20              20006,bos:1         192:1::1
```

BGP RIB-out

This command displays the routes that were advertised to peers.

Syntax:

show bgp rib-out <option>

Option	Description
-	Without any option, the command displays advertised BGP routes for all instances.
<afi>	BGP routing table summary for the given address family (AFI), all sub-address families and all instances. Supported AFI values are l2vpn, 'ipv4' and 'ipv6'.

Option	Description
<afi> <safi>	BGP routing table summary for the given address family (AFI) and sub-address family (SAFI), and all instances. Supported SAFI values are evpn, 'unicast', 'labeled-unicast', 'multicast', and 'vpn-unicast'.
<afi> <safi> detail	Detailed list view of the BGP routing table for the given address family (AFI) and sub-address family (SAFI), and all instances.
<afi> <safi> <prefix>	BGP routing table entry for the given prefix and all instances.
<afi> <safi> instance <instance-name>	BGP routing table summary for the given AFI, SAFI, and instance.
<afi> <safi> instance <instance-name> detail	Detailed list view of BGP routing table for the given AFI, SAFI, and instance.
<afi> <safi> instance <instance-name> <prefix>	BGP routing table entry for the given prefix and instance.
<afi> <safi> peer <name> / peer address <ip>	Peer name or address

Example: Summary view of the routes advertised to a peer

```
supervisor@rtbrick: op> show bgp rib-out
Instance: default, AFI: ipv6, SAFI: unicast
  Peer-group: spine, Sent routes: 4
    Prefix                                  MED             Lpref           Origin          Next Hop
AS Path
    192:1::1/128                            0               -               Incomplete      -
4200000003, 4200000000
    192:1::3/128                            0               -               Incomplete      -
4200000003
    192:1::5/128                            0               -               Incomplete      -
4200000003
    192:1::6/128                            0               -               Incomplete      -
4200000003
Instance: default, AFI: ipv6, SAFI: labeled-unicast
  Peer-group: spine, Sent routes: 4
    Prefix                                  MED             Lpref           Origin          Next Hop
AS Path
    192:1::1/128                            0               -               Incomplete      -
4200000003, 4200000000
    192:1::3/128                            0               -               Incomplete      -
4200000003
    192:1::5/128                            0               -               Incomplete      -
4200000003
    192:1::6/128                            0               -               Incomplete      -
4200000003
Instance: default, AFI: l2vpn, SAFI: evpn
  Peer-group: spine, Sent routes: 6
    Prefix                                  MED             Lpref           Origin          Next Hop
AS Path
    00.00.00.00.00.00.00.00.00.00:100/112   0               -               Incomplete      192:1::3
```

```
4200000003
    00.00.00.00.00.00.00.00.00.00:101/112         0              -                Incomplete      192:1::3
4200000003, 4200000000
    00.00.00.00.00.00.00.00.00.00:110/112         0              -                Incomplete      192:1::3
4200000003
    00.00.00.00.00.00.00.00.00.00:111/112         0              -                Incomplete      192:1::3
4200000003, 4200000000
    00.00.00.00.00.00.00.00.00.00:200/112         0              -                Incomplete      192:1::3
4200000003
    00.00.00.00.00.00.00.00.00.00:201/112         0              -                Incomplete      192:1::3
4200000003, 4200000000
```

BGP L2VPN

This command displays the BGP L2VPN information.

Syntax:

show bgp l2vpn <option>

Option	Description
pseudowire	Displays pseudowire information for all instances.
pseudowire instance <name>	Displays pseudowire information for the specified instance.

Example: Display L2VPN pseudowire information for instance evpn-vpws-vrf1

```
supervisor@rtbrick: op> show bgp l2vpn pseudowire instance evpn-vpws-vrf1
   Instance: evpn-vpws-vrf1 AFI: l2vpn, SAFI: evpn-vpws
   Peer IP: 12.0.0.2
   Route Distinguisher: 192.168.6.10:65006
   Number of local interfaces: 1
    Interface name  Prefix                                    Status         Local SID   Remote SID   Pop
Label            Push Label
    ifl-0/0/3/0  00.00.00.00.00.00.00.00.00.00:100/112      up             100         101
label:20004,bos:1    label:20004,bos:1
```

3.2. BGP-signaled L2VPN

3.2.1. BGP-signaled L2VPN Overview

The BGP-signaled L2VPN uses BGP for signaling and auto-discovery to establish multipoint Layer 2 VPN over the MPLS backbone network. The remote cross-connect is a point-to-point (P2P) service that connects two locations using the MPLS core network and MP-BGP. The remote cross-connect uses MPLS tunnels to traverse the backbone network. It offers a Layer 2 packet forwarding mode that

connects access circuits (ACs). The RBFS implementation of BGP-signaled L2VPN is in accordance with RFC-6624 which supports L2VPN using BGP for auto-discovery and Signaling.

Supported Standards

RFC Number	Description
6624	Layer 2 Virtual Private Networks Using BGP for Auto-Discovery and Signaling

BGP-signaled L2VPN Network Model

As shown in the figure below, a BGP-signaled L2VPN network contains the following building blocks:

- Customer edge (CE)—Customer device directly connected to the service provider network.
- Provider edge (PE)—Service provider device connected to CEs. PEs provide access to the Pseudowire network and forward traffic between customer network sites by using public tunnels.
- Attachment circuit (AC)—A physical or virtual link between a CE and a PE.
- Pseudowire (PW)—A virtual bidirectional connection between two PEs. A PW comprises a pair of virtual links in opposite directions.
- MPLS transport tunnel—A connection that carries one or more PWs across the MPLS core or IP backbone, such as an MPLS tunnel.
- Cross-connect—A connection formed by two physical or virtual circuits, such as ACs and PWs, that switches packets between them.

The figure below shows the protocol packet exchange process in the BGP-signaled L2VPN.

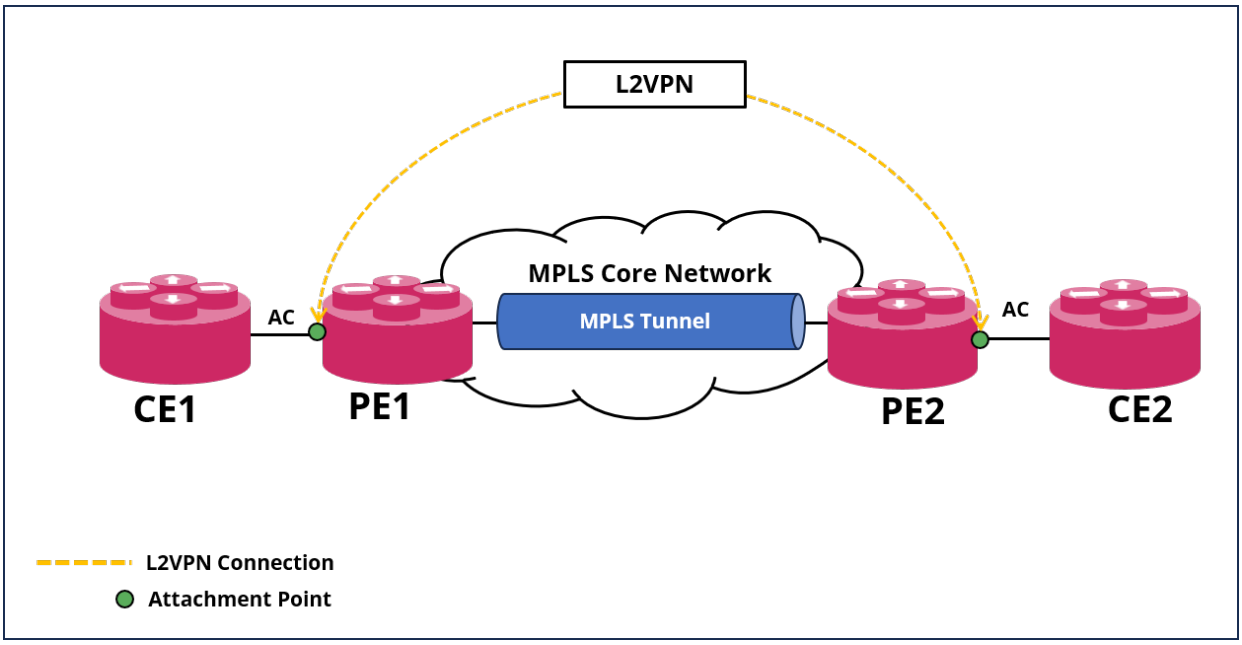


Figure 46. Protocol Packet Exchange Process in the BGP-signaled L2VPN

PE1 and PE2 are each configured with a BGP L2VPN instance. After the PE receives packets from the AC, it adds the PW label and sends them to the peer PE through the MPLS transport tunnel. After the other PE receives the packet via the MPLS transport path, it removes the PW label of the packets and forwards the packets to the AC bound to the PW.

VLAN Tag Manipulation

VLAN Tag Manipulation involve modifying VLAN tags on Ethernet frames to ensure proper traffic segmentation and delivery across a Layer 2 network. RBFS supports some VLAN Tag Manipulation operations which are used to manipulate tags on Ethernet frames as they enter or leave a network interface. These manipulations include adding, removing, and rewriting VLAN tags. VLAN manipulation operations can be performed both at ingress and egress nodes.

The following VLAN manipulation operations are supported for Layer 2 VPN interfaces:

- **push**: Adds a single outer VLAN tag to an Ethernet frame.
- **pop**: Removes a single outer VLAN tag from an Ethernet tag frame.
- **swap**: Rewrite a single outer VLAN tag of an Ethernet tag frame.
- **push–push**: Adds two VLAN tags to an Ethernet frame.
- **pop-pop**: Removes two VLAN tags from an Ethernet tags frame.

- **swap–swap**: Rewrite both the outer and inner VLAN tags of an Ethernet tags frame.
- **swap–push**: Rewrite the outer VLAN tag and add a new inner VLAN tag for Ethernet tags' frame.
- **pop–swap**: Removes the outer VLAN tag and rewrites the inner VLAN tag of an Ethernet tags' frame.

Supported CLI Options for VLAN Tag Manipulation Operations

The following table presents the various VLAN tag manipulation operations and supported CLI options.

CLI Options	pop	push	swap	push-push	pop-pop	swap-push	swap-swap	pop-swap
vlan-id	No	Yes	Yes	Yes	No	Yes	Yes	Yes
vlan-encapsulation	No	Yes	Yes	Yes	No	Yes	Yes	Yes
innervlan-id	No	No	No	Yes	No	Yes	Yes	No

Supported Platforms

Not all features are necessarily supported on each hardware platform. Refer to the *Platform Guide* for the features and the sub-features that are or are not supported by each platform.

Unsupported Features

The following features are not supported for the BGP-signaled L2VPN:

- Policy filtering options (at Address Family/Peer-Group/Instance levels)
- LAG interface as an attachment circuit
- LAG interface as an LSP MPLS path
- Route Reflection
- Add-Path
- VLAN change configuration on L2 IFL

Guidelines and Limitations

- The control-word flag is disabled by default in Layer 2 Attributes Extended Community. To ensure interoperability with RBFS, the control-word flag needs to be disabled.

3.2.2. Configuring BGP-signaled L2VPN

Configuration Hierarchy

The diagram illustrates the BGP-signaled L2VPN configuration hierarchy. All BGP-signaled L2VPN configurations are done within an instance, such as the default instance or an EVPN service instance.

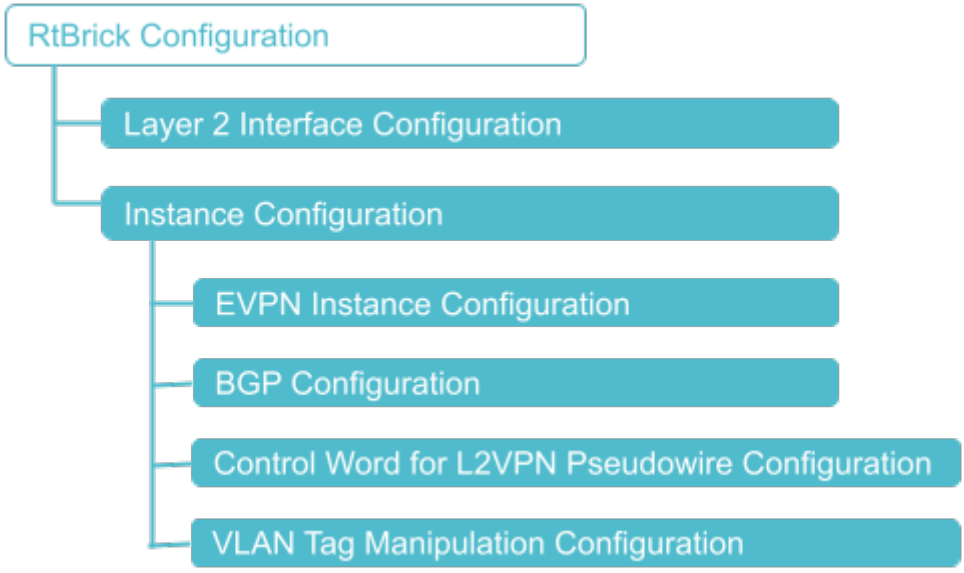


Figure 47. BGP-signaled L2VPN Configuration Hierarchy

Configuration Syntax and Commands

The following sections describe the BGP-signaled L2VPN configuration syntax and commands.

Layer 2 Interface Configuration

BGP-signaled L2VPN supports the configuration of Layer 2 logical interfaces.

Syntax:

set interface <name> <attribute> <value>

Attribute	Description
<name>	Specify the name of the interface. Example: ifp-0/0/1.
unit <unit-id>	Create a logical interface (also referred to as a sub-interface) under the physical interface
unit <unit-id> interface-type l2vpn-vpws	Specify the type of the L2VPN interface.
unit <unit-id> match-type port	Sets the "port" match-type for the L2VPN VPWS untagged interfaces. For tagged interfaces, "port" match-type is not supported. Ensure that there are no other tagged configurations for the interfaces when the port match-type is configured. When port matching is configured, it will match all traffic regardless of whether it is untagged, single-tagged, or double-tagged VLANs.
unit <unit-id> vlan <outer-vlan-id>	Outer VLAN ID.
unit <unit-id> vlan <inner-vlan-id>	Inner VLAN ID.
unit <unit-id> instance <instance>	Assign the logical interface to an instance.

The following example shows an untagged interface configuration along with "port" match-type for the L2VPN VPWS untagged interface.

```
set interface ifp-0/0/17 unit 0
set interface ifp-0/0/17 unit 0 interface-type l2vpn-vpws
set interface ifp-0/0/17 unit 0 match-type port
set interface ifp-0/0/17 unit 0 instance evpn-vpws-vrf1
commit
```

The following example shows a single-tagged interface configuration:

```
set interface ifp-0/0/17 unit 100
set interface ifp-0/0/17 unit 100 interface-type l2vpn-vpws
set interface ifp-0/0/17 unit 100 instance l2vpn_ce1
set interface ifp-0/0/17 unit 100 vlan 100
```

```
commit
```

The following example shows a double-tagged interface configuration:

```
set interface ifp-0/0/17 unit 200
set interface ifp-0/0/17 unit 200 interface-type l2vpn-vpws
set interface ifp-0/0/17 unit 200 instance l2vpn_ce2
set interface ifp-0/0/17 unit 200 vlan 200
set interface ifp-0/0/17 unit 200 inner-vlan 201
commit
```

EVPN Instance Configuration

An EVPN Instance (EVI) is a routing and forwarding instance of EVPN that covers all the participating PE routers in a VPN. EVI is configured per customer on the PE routers. Each EVI has a unique route distinguisher and one or more route targets.

Syntax:

set instance <name> <attribute> <value>

Attribute	Description
<name>	A unique name for the EVPN routing instance.
address-family <afi>	Address family identifier (AFI). Supported value: l2vpn
address-family <afi> <safi>	Subsequent address family identifier (SAFI). Supported values: vpls-vpws The SAFI vpls-vpws needs to be enabled on the VRF instance.
protocol	Specifies the routing protocol
route-distinguisher <as-number | ipv4-address:id>	The route distinguisher (RD) uniquely defines routes within an IPv4 network. PE routers use route distinguishers to identify which VPN a packet belongs to. Supported formats are <as-number:id> or <ipv4-address:id>.
ipv4-router-id <ipv4-router-id>	The router ID of the routing instance.

Attribute	Description
route-target (import | export) <rt-value>	Route targets (RT) are used to transfer routes between VPN instances. The RT identifies a subset of routes that should be imported to or exported from a particular VPN instance. You can configure an RT for importing or exporting routes or both.

In the following configuration, VRF instance AFI has been set to AFI: l2vpn and SAFI: vpls-vpws.

```
set instance l2vpn_ce1
set instance l2vpn_ce1 ipv4-router-id 182.1.6.4
set instance l2vpn_ce1 route-distinguisher 182.1.6.4:65006
set instance l2vpn_ce1 address-family l2vpn vpls-vpws
set instance l2vpn_ce1 address-family l2vpn vpls-vpws route-target import
target:182.1.6.0:65006
set instance l2vpn_ce1 address-family l2vpn vpls-vpws route-target export
target:182.1.6.0:65006
commit
```

BGP Configuration

BGP L2VPN VFT (Virtual Forwarding Table) Configuration

Syntax:

set instance <name> **protocol bgp** <attribute> <value>

Attribute	Description
<name>	Name of the routing instance
address-family <afi>	Address family identifier (AFI). Supported value: l2vpn
address-family <afi> <safi>	Subsequent address family identifier (SAFI). Supported value: vpls-vpws  The SAFI vpls-vpws needs to be enabled on the VFT instance.
local-as <as-number>	The AS number in four-byte format. The numbers allowed are from 1 to 4294967295.
interface <name>	Interface that is bound to L2VPN

Attribute	Description
nterface <name> local-site-id <local-site-id>	Specify the local site ID that is used to establish an EVPN PW between two PEs
interface <name> remote-site-id <remote-site-id>	Specify the remote site ID that is used to establish an EVPN PW between two PEs
interface <name> label-base <value>	Specify the label base value.

The following example configures l2vpn_ce1 instance for BGP L2VPN.

```
set instance l2vpn_ce1 protocol bgp local-as 65006
set instance l2vpn_ce1 protocol bgp address-family l2vpn vpls-vpws
set instance l2vpn_ce1 protocol bgp address-family l2vpn vpls-vpws interface ifl-
0/0/17/100
set instance l2vpn_ce1 protocol bgp address-family l2vpn vpls-vpws interface ifl-
0/0/17/100 local-site-id 300
set instance l2vpn_ce1 protocol bgp address-family l2vpn vpls-vpws interface ifl-
0/0/17/100 remote-site-id 301
set instance l2vpn_ce1 protocol bgp address-family l2vpn vpls-vpws interface ifl-
0/0/17/100 label-base 150000
commit
```

BGP L2VPN Configuration

Configuring the BGP L2VPN Address Family

Syntax:

set instance <name> **protocol bgp address-family l2vpn vpls**

Attribute	Description
<name>	Name of the routing instance

To configure BGP L2VPN VPLS on the default instance, enter the following command:

```
set instance default protocol bgp address-family l2vpn vpls
commit
```

Configuring Address Families for Peer Groups

Syntax:

set instance <instance-name> **protocol bgp peer-group** <pg-name> **address-family** <afi> <safi> <attribute> <value>

Attribute	Description
<afi>	Address family identifier (AFI). Supported value: l2vpn.
<safi>	Subsequent address family identifier (SAFI). Supported value: vpls
extended-nexthop	Enable extended-next-hop encoding for BGP peer groups to allow the transfer of IPv4 prefixes over an IPv6 connection.
update-nexthop (ipv4-address | ipv6-address) <address>	BGP nexthop address for routes advertised to this peer group

To configure BGP L2VPN Peer Group on the default instance, enter the following command:

```
set instance default protocol bgp peer-group spine address-family l2vpn vpls
commit
```

Configuring Control Word for L2VPN Pseudowire

A control word can be inserted between the label stack and the MPLS payload. Control word is disabled by default.

Syntax:

set instance <name> **protocol bgp address-family l2vpn vpls-vpws interface** <interface> **control-word enable**

Attribute	Description
<name>	Name of the routing instance.

Attribute	Description
<interface>	Name of the interface.

Example: Enter the following command to enable Control Word on the default instance.

```
set instance default protocol bgp peer-group spine address-family l2vpn vpls-vpws
interface ifl-0/0/1/10 control-word enable
commit
```

Configuring VLAN Tag Manipulation

The following section describes the VLAN tag manipulation configuration syntax and commands.

Syntax:

set interface <interface-name> **unit** <unit id> **[input-vlan-map** | **output-vlan-map]** <attribute> <value>

Attribute	Description
<name>	Specify the name of the interface.
unit <unit-id>	Specify the unit ID for the interface.
unit <unit-id> input-vlan-map	Ingress VLAN mapping.
unit <unit-id> output-vlan-map	Egress VLAN mapping
vlan-operation	Specify any of the VLAN operations supported: pop, pop-pop, pop-swap, push, push-push, swap, swap-push, and swap-swap.
vlan-encapsulation	Specify the encapsulation type for the VLAN operation. Supported only 802.1q.
vlan-id	Specify the outer VLAN for the VLAN operation specified.

Attribute	Description
inner-vlan-id	Specify the inner VLAN for the VLAN operation specified.

Example for VLAN operation 'push' configuration

```
supervisor@rtbrick.net: cfg> show config set interface ifp-0/1/4 unit 1000
set interface ifp-0/1/4 unit 1000
set interface ifp-0/1/4 unit 1000 interface-type l2vpn-vpws
set interface ifp-0/1/4 unit 1000 input-vlan-map vlan-operation push
set interface ifp-0/1/4 unit 1000 input-vlan-map vlan-id 1001
set interface ifp-0/1/4 unit 1000 instance l2vpn_ce1
set interface ifp-0/1/4 unit 1000 vlan 1000
```

Example: VLAN operation 'push' configuration output

```
supervisor@rtbrick.net: cfg> show config interface ifp-0/1/4 unit 1000
{
  "rtbrick-config:unit": [
    {
      "unit-id": 1000,
      "interface-type": "l2vpn-vpws",
      "input-vlan-map": {
        "vlan-operation": "push",
        "vlan-id": 1001
      },
      "instance": "l2vpn_ce1",
      "vlan": 1000
    }
  ]
}
```

Example for VLAN operation 'push-push' configuration

```
supervisor@rtbrick.net: cfg> show config set interface ifp-0/1/5 unit 2000
set interface ifp-0/1/5 unit 2000
set interface ifp-0/1/5 unit 2000 interface-type l2vpn-vpws
set interface ifp-0/1/5 unit 2000 input-vlan-map vlan-operation push-push
set interface ifp-0/1/5 unit 2000 input-vlan-map vlan-id 2000
set interface ifp-0/1/5 unit 2000 input-vlan-map inner-vlan-id 2001
set interface ifp-0/1/5 unit 2000 instance l2vpn_ce1
set interface ifp-0/1/5 unit 2000 vlan 2000
set interface ifp-0/1/5 unit 2000 inner-vlan 2
```

Example: VLAN operation 'push-push' configuration

```
supervisor@rtbrick.net: cfg> show config interface ifp-0/1/5 unit 2000
{
  "rtbrick-config:unit": [
```

```
    {
      "unit-id": 2000,
      "interface-type": "l2vpn-vpws",
      "input-vlan-map": {
        "vlan-operation": "push-push",
        "vlan-id": 2000,
        "inner-vlan-id": 2001
      },
      "instance": "l2vpn_ce1",
      "vlan": 2000,
      "inner-vlan": 2
    }
  ]
}
```

3.2.3. BGP L2VPN Operational Commands

BGP L2VPN Show Commands

The following show commands display the BGP L2VPN-related information.

BGP Summary

This command displays BGP protocol parameters like attributes or timers that are generic to the BGP instance.

Syntax:

show bgp summary <option>

Attribute	Description
-	Without any option, the command displays the information for all instances.
instance <instance-name>	BGP summary information for the given instance.

Example: BGP summary for instance l2vpn_ce1

```
supervisor@rtbrick: op> show bgp summary instance l2vpn_ce1
Instance: l2vpn_ce1
  General information
    Hostname: , Domain name:
    Local AS: 65006, Version: 4
    Local preference: 100, eBGP Protocol preference: 20, iBGP Protocol preference: 200
    Router ID: 182.1.6.4, Cluster ID: 182.1.6.4
  Capabilities
```

```
    Route refresh: True, AS4: True, Graceful restart: False, L2VPN VPLS-VPWS:True
  Best route selection
    Always compare MED: False, Ignore as path: False
    Ignore local preference: False, Ignore origin: False
    Ignore MED: False, Ignore route source: False
    Ignore router ID: False, Ignore uptime: True
    Ignore cluster length: False, Ignore peer IP: False
    Route select parameter: 0
  Timers
    Connect retry: 30s, Keepalive: 30s, Holdtime: 90s
  Statistics
    Peers configured: 0, Peers auto discovery: 0
      Peers in idle          : 0
      Peers in connect       : 0
      Peers in active        : 0
      Peers in opensent      : 0
      Peers in openconfirm   : 0
```

BGP Peer

The 'show bgp peer' commands display information on BGP peers.

Syntax:

show bgp peer <option>

Option	Description
-	Without any option, the commands display all BGP peers in all instances in a summary table format.
detail	Detailed information on all BGP peers in all instances in a list view.
<peer-name>	Detailed information on the peer with the given name.
address <peer-address>	Detailed information on the peer with the given IP address.
history	Displays BGP peer history information such as the peer state down reasons.
history <peer-address>	Displays BGP peer history information such as the peer state down reasons for a specified peer.
instance <instance-name>	Summary of all BGP peers in the given instance.
instance <instance-name> detail	Detailed information on all BGP peers in the given instance.

Option	Description
instance <instance-name> detail <peer-name>	Detailed information on the peer with the given name in the given instance.
instance <instance-name> detail address <peer-address>	Detailed information on the peer with the given IP address in the given instance.
statistics	Received and sent BGP prefixes per AFI/SAFI for all peers in all instances.
statistics peer <peer-name>	Received and sent BGP prefixes per AFI/SAFI for the peer with the given name.
statistics peer address <peer-address>	Received and sent BGP prefixes per AFI/SAFI for the peer with the given IP address.
statistics instance <instance-name> peer <peer-name>	Received and sent BGP prefixes per AFI/SAFI for the peer with the given name in the given instance.
statistics instance <instance-name> peer address <peer-address>	Received and sent BGP prefixes per AFI/SAFI for the peer with the given IP address in the given instance.

Example 1: BGP Peer Information for instance default

```
supervisor@rtbrick: op> show bgp peer instance default
Instance: default
  Peer         Remote AS    State         Up/Down Time       PfxRcvd     PfxSent
  spine1       4200000000   Established   0d:00h:59m:45s     55          77
  spine1       4200000000   Established   0d:00h:59m:48s     55          77
supervisor@rtbrick: op>
```

Example 2: Detailed view of BGP Peer Information

```
supervisor@rtbrick: op> show bgp peer detail
Peer: spine1, Peer IP: fe80::9a19:2cff:fe99:4701, Remote AS: 4200000000, Local: fe80::9a19:2cff:fe36:3e03,
Local AS: 4200000004, Any AS: False
  Type: ebgp, State: Established, Up/Down Time: 0d:01h:00m:40s
  Discovered on interface: ifl-0/0/2/1
  Last transition: Thu Apr 18 04:50:56 GMT +0000 2024, Flap count: 0
  Peer ID        : 192.1.0.1, Local ID  : 192.1.0.4
  Instance       : default, Peer group: spine
  6PE enabled    : False
  Timer values:
    Peer keepalive : 30s, Local keepalive: 30s
    Peer holddown  : 90s, Local holddown : 90s
    Connect retry  : 30s
  Timers:
    Connect retry timer : 0s
    Keepalive timer     : expires in 21s 796304us
```

```
    Holddown timer      : expires in 1m 13s 560627us
  NLRIs:
    Sent          : ['l2vpn-evpn', 'ipv4-unicast', 'ipv6-unicast', 'ipv4-vpn-unicast', 'ipv6-vpn-unicast',
'ipv4-vpn-multicast', 'l2vpn-vpls', 'ipv4-labeled-unicast', 'ipv6-labeled-unicast']
    Received      : ['l2vpn-evpn', 'ipv4-unicast', 'ipv6-unicast', 'ipv4-vpn-unicast', 'ipv6-vpn-unicast',
'ipv4-vpn-multicast', 'l2vpn-vpls', 'ipv4-labeled-unicast', 'ipv6-labeled-unicast']
    Negotiated    : ['l2vpn-evpn', 'ipv4-unicast', 'ipv6-unicast', 'ipv4-vpn-unicast', 'ipv6-vpn-unicast',
'ipv4-vpn-multicast', 'l2vpn-vpls', 'ipv4-labeled-unicast', 'ipv6-labeled-unicast']
  Capabilities:
    Addpath sent                  : None
    Addpath received              : None
    Addpath negotiated            : None
    Extended nexthop sent         : ['ipv4-unicast', 'ipv4-vpn-unicast', 'ipv4-vpn-multicast', 'ipv4-labeled-
unicast']
    Extended nexthop received     : ['ipv4-unicast', 'ipv4-labeled-unicast', 'ipv4-vpn-multicast', 'ipv4-vpn-
unicast']
    Extended nexthop negotiated   : ['ipv4-unicast', 'ipv4-labeled-unicast', 'ipv4-vpn-multicast', 'ipv4-vpn-
unicast']
    Capabilities:
      Feature                     Sent            Received        Negotiated
      Route refresh               True            True            True
      4 byte AS                   True            True            True
      Graceful restart            False           False           False
      Link local only             False           False           False
  Prefix Limit:
  End of RIB:
    Address family                Sent                                Received
    IPv4 unicast                  Thu Apr 18 04:50:59 GMT +0000 2024  Thu Apr 18 04:50:59 GMT +0000 2024
    IPv4 labeled-unicast          Thu Apr 18 04:50:59 GMT +0000 2024  Thu Apr 18 04:50:59 GMT +0000 2024
    IPv6 unicast                  Thu Apr 18 04:50:59 GMT +0000 2024  Thu Apr 18 04:50:59 GMT +0000 2024
    IPv6 labeled-unicast          Thu Apr 18 04:50:59 GMT +0000 2024  Thu Apr 18 04:50:59 GMT +0000 2024
    IPv4 VPN-unicast              Thu Apr 18 04:50:59 GMT +0000 2024  Thu Apr 18 04:50:59 GMT +0000 2024
    IPv6 VPN-unicast              Thu Apr 18 04:50:59 GMT +0000 2024  Thu Apr 18 04:50:59 GMT +0000 2024
    IPv4 VPN-multicast            Thu Apr 18 04:50:59 GMT +0000 2024  Thu Apr 18 04:50:59 GMT +0000 2024
    L2VPN VPLS                   Thu Apr 18 04:50:59 GMT +0000 2024  Thu Apr 18 04:50:59 GMT +0000 2024
    L2VPN EVPN                    Thu Apr 18 04:50:59 GMT +0000 2024  Thu Apr 18 04:50:59 GMT +0000 2024
  Message stats:
    Session stats:
      Direction   Open         Update       Keepalive    Notify       Route refresh
      Input       0            0            72           0            0
      Output      0            0            71           0            0
    Total stats:
      Input       0            0            72           0            0
      Output      0            0            71           0            0
    Route stats:
      Address family                Received     Sent         Prefix limit Idle timeout
      IPv4 unicast                  0            0            0            0
      IPv4 labeled-unicast          0            0            0            0
      IPv6 unicast                  0            0            0            0
      IPv6 labeled-unicast          0            0            0            0
      IPv4 VPN-unicast              0            0            0            0
      IPv6 VPN-unicast              0            0            0            0
      IPv4 VPN-multicast            0            0            0            0
     L2VPN VPLS                     0            0            0            0
      L2VPN EVPN                    0            0            0            0
<...>
```

Example 3: BGP Peer Statistics for a specific peer

```
supervisor@rtbrick: op> show bgp peer statistics peer address fe80::781a:c6ff:fec0:1
Instance: default
  Peer                          AFI     SAFI               PfxRcvd    PfxSent
  spine1                        ipv4    unicast            4          5
                                ipv4    labeled-unicast    4          5
                                ipv6    unicast            4          5
                                ipv6    labeled-unicast    4          5
                                ipv4    vpn-unicast        14         18
                                ipv6    vpn-unicast        14         18
                                ipv4    multicast          0          0
                                ipv4    vpn-multicast      4          7
```

```
                                l2vpn   vpls              3          6
                                l2vpn   evpn              4          8
```

Example 4: BGP Peer history for a specified peer

```
supervisor@rtbrick.net: op> show bgp peer history peer address 192:168::40
Instance: vrf1
  Peer Address               Source Address             Type             Last
Reset Reason
  192:168::40                192:168:5::20              FSM Error        FSM
Error, Sub-Code: Unexpected message in OpenSent State
```

BGP RIB-in

This command displays the received routes.

Syntax:

show bgp rib-in <option>

Option	Description
-	Without any option, the command displays information on the received BGP routing table on all instances in a summary table format.
<afi>	BGP routing table summary for the given address family (AFI), all sub-address families and all instances. Supported AFI values are 'ipv4', 'ipv6' and l2vpn.
<afi> <safi>	BGP routing table summary for the given address family (AFI) and sub-address family (SAFI), and all instances. Supported SAFI values are evpn, 'labeled-unicast', 'unicast', 'vpn-multicast', 'vpn-unicast', and vpls.
<afi> <safi> detail	Detailed list view of the BGP routing table for the given address family (AFI) and sub-address family (SAFI), and all instances.
<afi> <safi> <prefix>	BGP routing table entry for the given prefix and all instances.

Option	Description
<afi> <safi> instance <instance-name>	BGP routing table summary for the given AFI, SAFI, and instance.
<afi> <safi> instance <instance-name> detail	Detailed list view of BGP routing table for the given AFI, SAFI, and instance.
<afi> <safi> instance <instance-name> <prefix>	BGP routing table entry for the given prefix and instance.
<afi> <safi> community <community-name>	BGP community details for the given AFI, SAFI, and instance.
<afi> <safi> error	BGP route with error status for the given AFI, SAFI, and instance.
<afi> <safi> peer <name> / peer address <ip>	Peer name or address

Example 1: Summary view of the BGP rib-in where you can find received information for the BGP L2VPN instances like l2vpn_ce1, l2vpn_ce2, and l2vpn_ce3.

```
supervisor@rtbrick: op> show bgp rib-in
Flags: & - Imported, ! - Error
Instance: default, AFI: ipv6, SAFI: unicast
  Hostname: Local, Peer IP: 0.0.0.0
  Source IP: 0.0.0.0, Total routes: 3
    Prefix                                    Next Hop                          MED        Lpref
AS Path    Status
    192:1::3/128                                                                0          100
-          Valid
    192:1::5/128                                                                0          100
-          Valid
    192:1::6/128                                                                0          100
-          Valid
  Hostname: spine1, Peer IP: fe80::781a:c6ff:fec0:1
  Source IP: fe80::7857:d6ff:fec0:0, Total routes: 1
    Prefix                                    Next Hop                          MED        Lpref
AS Path    Status
    192:1::1/128                              fe80::781a:c6ff:fec0:1            0          -
4200000000 Valid
Instance: default, AFI: ipv6, SAFI: labeled-unicast
  Hostname: Local, Peer IP: 0.0.0.0
  Source IP: 0.0.0.0, Total routes: 3
    Prefix                                    Next Hop                          MED        Lpref
AS Path    Status
    192:1::3/128                                                                0          100
-          Valid
    192:1::5/128                                                                0          100
-          Valid
    192:1::6/128                                                                0          100
-          Valid
  Hostname: spine1, Peer IP: fe80::781a:c6ff:fec0:1
  Source IP: fe80::7857:d6ff:fec0:0, Total routes: 1
    Prefix                                    Next Hop                          MED        Lpref
AS Path    Status
    192:1::1/128                              fe80::781a:c6ff:fec0:1            0          -
4200000000 Valid
Instance: l2vpn_ce1, AFI: l2vpn, SAFI: vpls-vpws
  Hostname: Local, Peer IP: 0.0.0.0
  Source IP: 0.0.0.0, Total routes: 1
```

```
    Prefix                                    Next Hop                          MED        Lpref
AS Path    Status
    00.00.00.00.00.00.00.00.00.00:300/112                                       0          100
-          Valid
Instance: l2vpn_ce2, AFI: l2vpn, SAFI: vpls-vpws
  Hostname: Local, Peer IP: 0.0.0.0
  Source IP: 0.0.0.0, Total routes: 1
    Prefix                                    Next Hop                          MED        Lpref
AS Path    Status
    00.00.00.00.00.00.00.00.00.00:310/112                                       0          100
-          Valid
Instance: l2vpn_ce3, AFI: l2vpn, SAFI: vpls-vpws
  Hostname: Local, Peer IP: 0.0.0.0
  Source IP: 0.0.0.0, Total routes: 1
    Prefix                                    Next Hop                          MED        Lpref
AS Path    Status
    00.00.00.00.00.00.00.00.00.00:400/112                                       0          100
-          Valid
Instance: default, AFI: l2vpn, SAFI: vpls
  Hostname: spine1, Peer IP: fe80::781a:c6ff:fec0:1
  Source IP: fe80::7857:d6ff:fec0:0, Total routes: 3
    Prefix                                    Next Hop                          MED        Lpref
AS Path    Status
    00.00.00.00.00.00.00.00.00.00:301/112        192:1::1                       0          -
4200000000 Valid
    00.00.00.00.00.00.00.00.00.00:311/112        192:1::1                       0          -
4200000000 Valid
    00.00.00.00.00.00.00.00.00.00:401/112        192:1::1                       0          -
4200000000 Valid
<...>
```

Example 2: Summary view of the BGP rib-in where you can find received information for address family l2vpn vpls.

```
supervisor@rtbrick: op> show bgp rib-in l2vpn vpls
Flags: & - Imported, ! - Error
Instance: default, AFI: l2vpn, SAFI: vpls
   Hostname: spine1, Peer IP: fe80::9a19:2cff:fe99:4701
   Source IP: fe80::9a19:2cff:fe36:3e03, Total routes: 3
    Prefix                                    Next Hop                          MED        Lpref
AS Path    Status
    00.00.00.00.00.00.00.00.00.00:301/112        192:1::1                       0          -
4200000000, 4200000003 Valid
    00.00.00.00.00.00.00.00.00.00:311/112        192:1::1                       0          -
4200000000, 4200000003 Valid
    00.00.00.00.00.00.00.00.00.00:401/112        192:1::1                       0          -
4200000000, 4200000003 Valid
```

Example 3: Summary view of the BGP rib-in with the error flag.

```
supervisor@rtbrick.net: op> show bgp rib-in ipv4 unicast peer address 12.0.0.2
Flags: & - Imported, ! - Error
Instance: default, AFI: ipv4, SAFI: unicast
  Hostname: P1, Peer IP: 12.0.0.2
  Source IP: 12.0.0.1, Total routes: 4
    Flags  Prefix           Next Hop   MED       Lpref       AS Path
           12.0.0.0/24      12.0.0.2   0         -           4200000002
           12.1.0.0/24      12.0.0.2   0         -           4200000002
           192.168.0.20/32  12.0.0.2   0         -           4200000002
           192.168.0.21/32  12.0.0.2   0         -           4200000002
```

BGP FIB

The 'show bgp fib' commands display the BGP forwarding table.

Syntax:

show bgp fib <option>

Option	Description
-	Without any option, the commands display the BGP forwarding table for all address families and all instances in a summary table format.
<afi>	BGP forwarding table summary for the given address family (AFI), all sub-address families and all instances. Supported AFI values are l2vpn, 'ipv4' and 'ipv6'.
<afi> <safi>	BGP forwarding table summary for the given address family (AFI) and sub-address family (SAFI), and all instances. Supported SAFI values are 'unicast', 'labeled-unicast', 'vpn-multicast', 'vpn-unicast', 'evpn-vpws', and 'vpls-vpws'.
<afi> <safi> detail	Detailed list view of the BGP forwarding table for the given address family (AFI) and sub-address family (SAFI), and all instances.
<afi> <safi> <prefix>	BGP forwarding table entry for the given prefix and all instances.
<afi> <safi> instance <instance-name>	BGP forwarding table summary for the given AFI, SAFI, and instance.
<afi> <safi> instance <instance-name> detail	Detailed list view of BGP forwarding table for the given AFI, SAFI, and instance.
<afi> <safi> instance <instance-name> <prefix>	BGP forwarding table entry for the given prefix and instance.

Example: Summary view of the BGP FIB

```
supervisor@rtbrick: op> show bgp fib
Instance: default, AFI: ipv6, SAFI: unicast
  Prefix                                   Preference      Out Label           Next Hop
```

```
  192:1::1/128                                20              -                   fe80::781a:c6ff:fec0:1
Instance: default, AFI: ipv6, SAFI: labeled-unicast
  Prefix                                      Preference      Out Label           Next Hop
  192:1::1/128                                20              -                   fe80::781a:c6ff:fec0:1
Instance: l2vpn_ce1, AFI: l2vpn, SAFI: vpls-vpws
  Prefix                                      Preference      Out Label           Next Hop
  00.00.00.00.00.00.00.00.00.00:301/112       20              150000,bos:1         192:1::1
Instance: l2vpn_ce2, AFI: l2vpn, SAFI: vpls-vpws
  Prefix                                      Preference      Out Label           Next Hop
  00.00.00.00.00.00.00.00.00.00:311/112       20              110000,bos:1         192:1::1
Instance: l2vpn_ce3, AFI: l2vpn, SAFI: vpls-vpws
  Prefix                                      Preference      Out Label           Next Hop
  00.00.00.00.00.00.00.00.00.00:401/112       20              120000,bos:1         192:1::1
```

BGP RIB-out

This command displays the routes that were advertised to peers.

Syntax:

show bgp rib-out <option>

Option	Description
-	Without any option, the command displays advertised BGP routes for all instances.
<afi>	BGP routing table summary for the given address family (AFI), all sub-address families and all instances. Supported AFI values are l2vpn, 'ipv4' and 'ipv6'.
<afi> <safi>	BGP routing table summary for the given address family (AFI) and sub-address family (SAFI), and all instances. Supported SAFI values are evpn, 'unicast', 'labeled-unicast', 'multicast', 'vpn-unicast', and vpls.
<afi> <safi> detail	Detailed list view of the BGP routing table for the given address family (AFI) and sub-address family (SAFI), and all instances.
<afi> <safi> <prefix>	BGP routing table entry for the given prefix and all instances.
<afi> <safi> instance <instance-name>	BGP routing table summary for the given AFI, SAFI, and instance.
<afi> <safi> instance <instance-name> detail	Detailed list view of BGP routing table for the given AFI, SAFI, and instance.

Option	Description
<afi> <safi> instance <instance-name> <prefix>	BGP routing table entry for the given prefix and instance.
<afi> <safi> peer <name> / peer address <ip>	Peer name or address

Example: Summary view of the routes advertised to a peer

```
supervisor@rtbrick: op> show bgp rib-out
Instance: default, AFI: ipv6, SAFI: unicast
  Peer-group: spine, Sent routes: 4
    Prefix                                  MED             Lpref           Origin          Next Hop
AS Path
    192:1::1/128                            0               -               Incomplete      -
4200000003, 4200000000
    192:1::3/128                            0               -               Incomplete      -
4200000003
    192:1::5/128                            0               -               Incomplete      -
4200000003
    192:1::6/128                            0               -               Incomplete      -
4200000003
Instance: default, AFI: ipv6, SAFI: labeled-unicast
  Peer-group: spine, Sent routes: 4
    Prefix                                  MED             Lpref           Origin          Next Hop
AS Path
    192:1::1/128                            0               -               Incomplete      -
4200000003, 4200000000
    192:1::3/128                            0               -               Incomplete      -
4200000003
    192:1::5/128                            0               -               Incomplete      -
4200000003
    192:1::6/128                            0               -               Incomplete      -
4200000003
Instance: default, AFI: l2vpn, SAFI: vpls
  Peer-group: spine, Sent routes: 3
    Prefix                                  MED             Lpref           Origin          Next Hop
AS Path
    00.00.00.00.00.00.00.00.00.00:300/112   0               -               Incomplete      192:1::3
4200000003
    00.00.00.00.00.00.00.00.00.00:310/112   0               -               Incomplete      192:1::3
4200000003, 4200000000
    00.00.00.00.00.00.00.00.00.00:400/112   0               -               Incomplete      192:1::3
4200000003
```

BGP L2VPN

This command displays the BGP L2VPN information.

Syntax:

show bgp l2vpn <option>

Option	Description
pseudowire	Displays pseudowire peer IP information for all instances.
pseudowire instance <name>	Displays pseudowire peer IP information for the specified instance.
pseudowire detail	Displays detailed pseudowire peer IP information for all instances.

Example 1: Display L2VPN pseudowire information for instance l2vpn_ce1

```
supervisor@rtbrick: op> show bgp l2vpn pseudowire instance l2vpn_ce1
   Instance: l2vpn_ce1, AFI: l2vpn, SAFI: vpls-vpws
   Peer IP: 12.0.0.2
   Route Distinguisher: 192.1.6.3:65006
   Number of local interfaces: 1
    Interface name       Prefix                                      Status         Local SID  Remote SID  Pop
Label          Push Label
    ifl-0/1/7/100        00.00.00.00.00.00.00.00.00.00:300/112      up             300        301
label:150001,bos:1 label:150001
```

Example 2: Display L2VPN pseudowire information

```
supervisor@rtbrick.net: cfg> show bgp l2vpn pseudowire
Instance: vrf1-blue, AFI: l2vpn, SAFI: evpn-vpws
  Route Distinguisher: 192.168.3.10:65010
  Number of local interfaces: 4
    Interface name       Prefix                                      Status          Local SID  Remote SID Pop
Label          Push Label
    ifp-0/0/2/101     00.00.00.00.00.00.00.00.00.00:300/112      Up                   300        301
label:20018,bos:1  label:20017,bos:1
    ifp-0/0/2/201     00.00.00.00.00.00.00.00.00.00:310/112      Up                   310        311
label:20019,bos:1  label:20018,bos:1
    ifp-0/0/2/401     00.00.00.00.00.00.00.00.00.00:401/112      Up                   401        402 -
-
    ifp-0/0/3/401     00.00.00.00.00.00.00.00.00.00:402/112      Up                   402        401 -
-
```

Example 3: Detailed view of L2VPN pseudowire information

```
supervisor@rtbrick.net: cfg> show bgp l2vpn pseudowire detail
Instance: vrf1-blue, AFI: l2vpn, SAFI: evpn-vpws
  Route distinguisher: 192.168.3.10:65010, Number of local interfaces: 4
    Prefix: 00.00.00.00.00.00.00.00.00.00:300/112
      Peer IP:  12.0.0.2, Interface name: ifp-0/0/2/101, Status: Up
      Local SID: 300, Remote SID: 301, Pseudowire type: Remote cross connect
      Pop label: label:519936,bos:1, Push label: label:519936,bos:1, Control Word: False
    Prefix: 00.00.00.00.00.00.00.00.00.00:310/112
      Peer IP:  12.0.0.2, Interface name: ifp-0/0/2/201, Status: Up
      Local SID: 310, Remote SID: 311, Pseudowire type: Remote cross connect
      Pop label: label:519937,bos:1, Push label: label:519937,bos:1, Control Word: True
    Prefix: -
      Peer IP:  -, Interface name: ifp-0/0/2/401, Status: Local failure
      Local SID: 401, Remote SID: 402, Pseudowire type: Unknown
      Pop label: -, Push label: -, Control Word: False
```

```
    Prefix: 00.00.00.00.00.00.00.00.00.00:402/112
      Peer IP:  -, Interface name: ifp-0/0/3/401, Status: Remote failure
      Local SID: 402, Remote SID: 401, Pseudowire type: Unknown
      Pop label: label:519980,bos:1, Push label: -, Control Word: False
  <...>
```

3.3. LDP-signaled L2VPN

3.3.1. LDP-signaled L2VPN Overview

The LDP-signaled L2VPN uses Targeted Label Distribution Protocol (T-LDP) for signaling to establish Pseudowire over the MPLS backbone network. The Pseudowire is a point-to-point (P2P) service that connects two locations using the MPLS core network and uses T-LDP for signaling. The Pseudowire uses MPLS tunnels to traverse the backbone network. It offers a Layer 2 packet forwarding mode that connects attachment circuits (ACs). The RBFS implementation of LDP-signaled L2VPN is in accordance with RFC 4447 which supports L2VPN using LDP for signaling.

Supported Standards

RFC Number	Description
4447	Pseudowire Setup and Maintenance Using the Label Distribution Protocol (LDP)



RFC and draft compliance are partial except as specified.

LDP-signaled L2VPN Network Model

As shown in the figure below, a LDP-signaled L2VPN network contains the following building blocks:

- Customer edge (CE)—Customer device directly connected to the service provider network.
- Provider edge (PE)—Service provider device connected to CEs. PEs provide access to the Pseudowire network and forward traffic between customer network sites by using public tunnels.
- Attachment circuit (AC)—A physical or virtual link between a CE and a PE.
- Pseudowire (PW)—A virtual bidirectional connection between two PEs. A PW

comprises a pair of virtual links in opposite directions.

- MPLS transport tunnel—A connection that carries one or more PWs across the MPLS core or IP backbone, such as an MPLS tunnel.
- Cross-connect—A connection formed by two physical or virtual circuits, such as ACs and PWs, that switches packets between them.

The figure below shows the protocol packet exchange process in the LDP-signaled L2VPN.

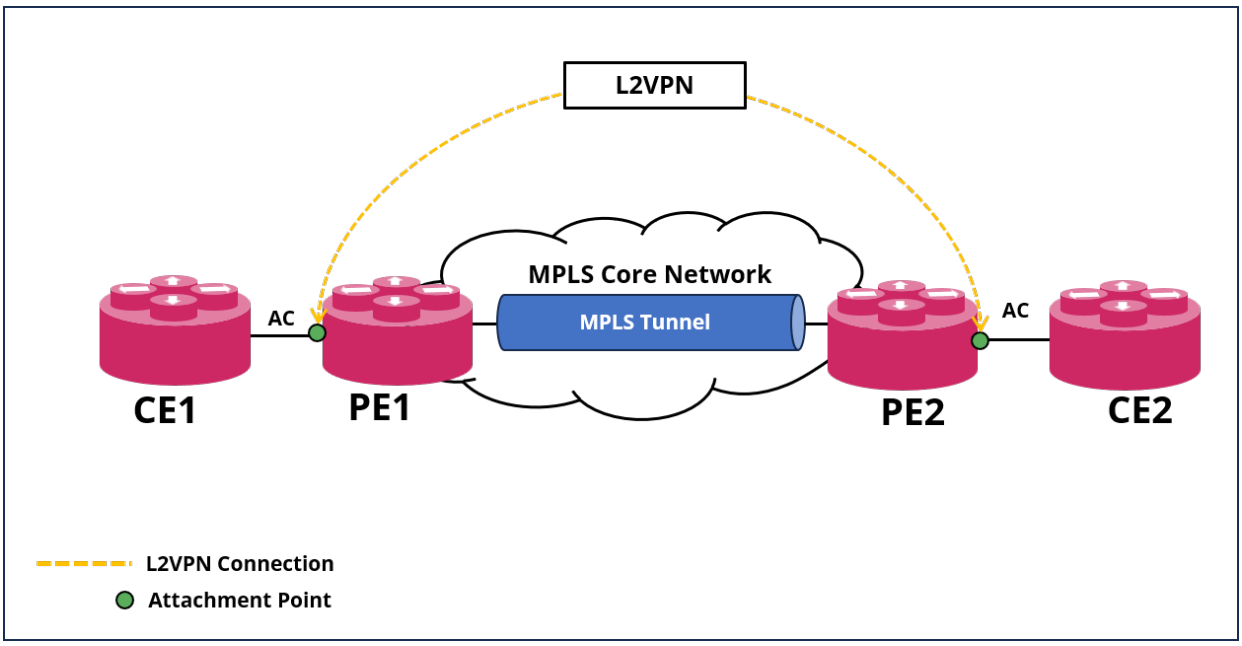


Figure 48. Protocol Packet Exchange Process in the LDP-signaled L2VPN

PE1 and PE2 are each configured with a LDP L2VPN instance with T-LDP neighbors to carry the Pseudowire (PW) tunnel information. After the PE receives packets from the AC, it adds the PW label and sends them to the peer PE through the MPLS transport tunnel. After the other PE receives the packet via the MPLS transport path, it removes the PW label of the packets and forwards the packets to the AC bound to the PW.

Pseudowire Redundancy

Pseudowire redundancy is supported only for the Provider Edge (PE) routers.

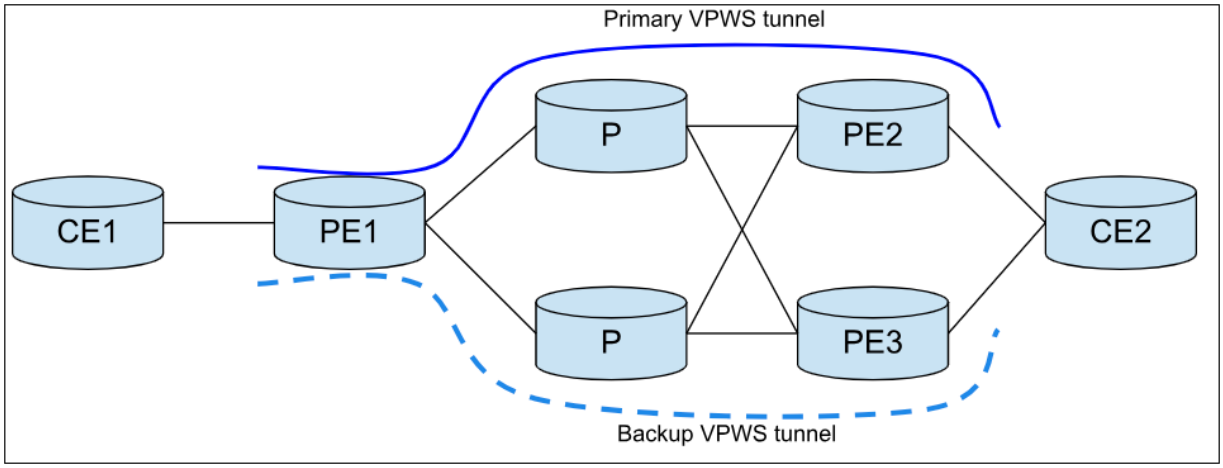


Figure 49. Pseudowire Redundancy

As shown in the figure above, PE1 has two VPWS tunnels. The tunnel from PE1 to PE2 is the primary tunnel, while the tunnel from PE1 to PE3 serves as the backup tunnel. Switching back to the primary pseudowire is not performed even if it recovers.

In the scenario with PE1 and PE2, where P3 acts as redundancy as shown in the diagram above, switching switching is exclusively executed by PE1 when certain conditions are met:

- The LDP session with the primary remote PE is down.
- A label withdrawal occurs from PE2.
- The MPLS tunnel to PE2 is down.
- The "request switch-over ldp l2vpn" operational command can be entered to switch to the backup PE. For details, see the request switch-over section.

Guidelines and Limitations

- The control-word flag is disabled by default, which can be enabled if required. For more details, see the Configuring LDP-signaled L2VPN section.

Supported Platforms

Not all features are necessarily supported on each hardware platform. Refer to the *Platform Guide* for the features and the sub-features that are or are not supported by each platform

3.3.2. Configuring LDP-signaled L2VPN

Configuration Hierarchy

The diagram illustrates the LDP-signaled L2VPN configuration hierarchy. All LDP-signaled L2VPN configurations are done within an instance, such as the default instance or VRF instance.

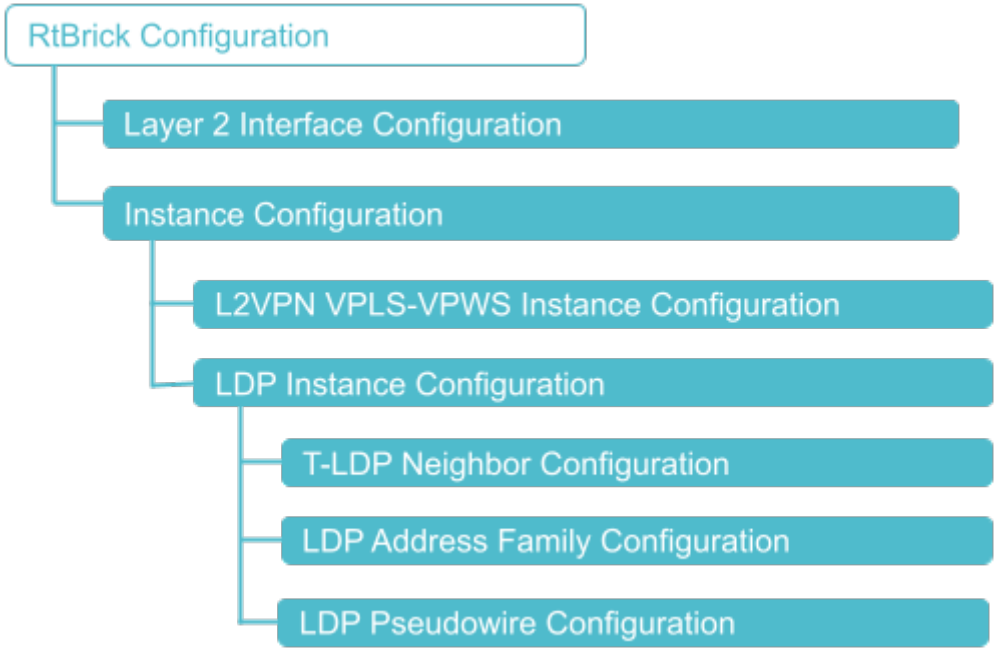


Figure 50. LDP-signaled L2VPN Configuration Hierarchy

Configuration Syntax and Commands

The following sections describe the LDP-signaled L2VPN configuration syntax and commands.

Layer 2 Interface Configuration

LDP-signaled L2VPN supports the configuration of Layer 2 logical interfaces.

Syntax:

```
set interface <name> <attribute> <value>
```

Attribute	Description
<name>	Specify the name of the interface. Example: ifp-0/0/1.
unit <unit-id>	Create a logical interface (also referred to as a sub-interface) under the physical interface
unit <unit-id> interface-type l2vpn-vpws	Specify the type of the L2VPN interface.
unit <unit-id> vlan <outer-vlan-id>	Outer VLAN ID.
unit <unit-id> vlan <inner-vlan-id>	Inner VLAN ID.
unit <unit-id> instance <instance>	Assign the logical interface to an instance.

The following example shows a single-tagged interface configuration:

```
set interface ifp-0/0/17 unit 100
set interface ifp-0/0/17 unit 100 interface-type l2vpn-vpws
set interface ifp-0/0/17 unit 100 instance default
set interface ifp-0/0/17 unit 100 vlan 100
commit
```

The following example shows a double-tagged interface configuration:

```
set interface ifp-0/0/17 unit 200
set interface ifp-0/0/17 unit 200 interface-type l2vpn-vpws
set interface ifp-0/0/17 unit 200 instance default
set interface ifp-0/0/17 unit 200 vlan 200
set interface ifp-0/0/17 unit 200 inner-vlan 201
commit
```

Instance Configuration

L2VPN VPLS-VPWS Instance Configuration

This section explains how to enable the L2VPN vpls-vpws address family in the instance.



By default, the SAFI vpls-vpws is disabled, which you should enable for L2VPN Pseudowire.

Syntax:

set instance <name> <attribute> <value>

Attribute	Description
<name>	A unique name for the routing instance.
address-family <afi>	Address family identifier (AFI). Supported value: l2vpn
address-family <afi> <safi>	Subsequent address family identifier (SAFI). Supported values: vpls-vpws The SAFI vpls-vpws needs to be enabled on the instance.

Example: L2VPN VPLS-VPWS Instance Configuration

```
set instance default address-family l2vpn vpls-vpws
```

LDP Instance Configuration

LDP Targeted Neighbor Configuration

The targeted neighbor configuration establishes an LDP neighbor with a remote neighbor that is not directly connected.

Syntax:

set instance <instance> **protocol ldp targeted-neighbor** <attribute> <value>

Attribute	Description
ipv4 <neighbor-address>	IPv4 address of the remote LDP neighbor.
ipv4 <neighbor-address> <source-address>	Neighbhor address to which ldp hello is sent
ipv4 <neighbor-address> <source-address> hold-time <hold-time>	Targeted hold time, <0-65535>, default 45s

Attribute	Description
ipv4 <neighbor-address> <source-address> interval <interval>	Targeted hello messages interval, <0-65535>, default 15s
ipv4 <neighbor-address> <source-address> neighbor-type <receiver |sender>	Specifies the neighbor type, that is, sender or receiver.
ipv6 <neighbor-address>	IPv6 address of the remote LDP neighbor.
ipv6 <neighbor-address> <source-address>	Neighbhor address to which ldp hello is sent
ipv6 <neighbor-address> <source-address> hold-time <hold-time>	Targeted hold time, <0-65535>, default 45s
ipv6 <neighbor-address> <source-address> interval <interval>	Targeted hello messages interval, <0-65535>, default 15s
ipv6 <neighbor-address> <source-address> neighbor-type <receiver |sender>	Specifies the neighbor type, that is, sender or receiver.

```
set instance default protocol ldp targeted-neighbor ipv4 198.51.100.1 198.51.100.2
set instance default protocol ldp targeted-neighbor ipv4 198.51.100.5 198.51.100.2
```

Example: LDP Targeted Neighbor Configuration

```
supervisor@rtbrick>SPINE01: cfg> show config instance default protocol ldp
targeted-neighbor
{
  "rtbrick-config:targeted-neighbor": {
    "ipv4": [
      {
        "neighbor-address": "198.51.100.1",
        "source-address": "198.51.100.2"
      },
      {
        "neighbor-address": "198.51.100.5",
        "source-address": "198.51.100.2"
      }
    ]
  }
```

```
}
```

LDP Address Family Configuration

The address-family command allows you to enable the address families that LDP will route and configure settings that are specific to that address family.



By default, the SAFI "vpls-vpws" is disabled, which you should enable for L2VPN Pseudowire.

Syntax:

set instance <instance-name> **protocol ldp address-family** <attribute> <value>

Attribute	Description
<afi>	Address family identifier (AFI). Supported values: l2vpn
<afi> <safi>	Subsequent address family. Supported values: vpls-vpws
<afi> <safi> status <enable|disable>	Enable or disable address family.

Example 1: LDP Address Family Configuration for L2VPN Pseudowire

```
set instance default protocol ldp address-family l2vpn vpls-vpws status enable
```

```
supervisor@rtbrick>SPINE01: cfg> show config instance default protocol ldp
address-family
{
  "rtbrick-config:address-family": [
    {
      "afi": "l2vpn",
      "safi": "vpls-vpws",
      "status": "enable"
    }
  ]
}
```

LDP Pseudowire Configuration

Syntax:

set instance <instance-name> **protocol ldp vpls-vpws** <attribute> <value>

Attribute	Description
interface <interface>	Attachment Circuit L2VPN Interface.
interface <interface> pseudowire-id <pseudowire-id>	Specifies the pseudowire identifier.
interface <interface> neighbor <ipv4/ipv6> address <ipaddress>	Specifies the T-LDP neighbor.
interface <interface> backup-neighbor <ipv4/ipv6> address <ipaddress>	Specifies the redundancy T-LDP neighbor.
interface <interface> control-word <enable/disable>	Specifies whether control-word is enabled or disabled. Default value: disable

Example 1: LDP VPWS Configuration

```
set instance default protocol ldp vpls-vpws interface ifl-0/0/17/100
set instance default protocol ldp vpls-vpws interface ifl-0/0/17/100 pseudowire-id
100
set instance default protocol ldp vpls-vpws interface ifl-0/0/17/100 control-word
enable
set instance default protocol ldp vpls-vpws interface ifl-0/0/17/100 neighbor ipv4
address 192.51.100.1
```

```
supervisor@rtbrick>SPINE01: cfg> show config instance default protocol ldp vpls-
vpws interface ifl-0/0/17/100
{
  "rtbrick-config:interface": [
    {
      "name": "ifl-0/0/17/100",
      "pseudowire-id": 100,
      "control-word": "enable",
      "neighbor": {
        "ipv4": {
```

```
          "address": "192.51.100.1"
        }
      }
    }
  ]
}
```

Example 2: LDP VPWS Redundancy Configuration

```
set instance default protocol ldp vpls-vpws interface ifl-0/0/17/200
set instance default protocol ldp vpls-vpws interface ifl-0/0/17/200 pseudowire-id
200
set instance default protocol ldp vpls-vpws interface ifl-0/0/17/200 control-word
enable
set instance default protocol ldp vpls-vpws interface ifl-0/0/17/200 neighbor ipv4
address 192.51.100.1
set instance default protocol ldp vpls-vpws interface ifl-0/0/17/200 backup-
neighbor ipv4 address 192.51.100.5
```

```
supervisor@rtbrick>SPINE01: cfg> show config instance default protocol ldp vpls-
vpws interface ifl-0/0/17/200
{
  "rtbrick-config:interface": [
    {
      "name": "ifl-0/0/17/200",
      "pseudowire-id": 200,
      "control-word": "enable",
      "neighbor": {
        "ipv4": {
          "address": "192.51.100.1"
        }
      },
      "backup-neighbor": {
        "ipv4": {
          "address": "192.51.100.5"
        }
      }
    }
  ]
}
```

3.3.3. LDP L2VPN Operational Commands

show ldp binding

Syntax:

show ldp binding <option>

Option	Description
-	Without any option, this command displays a summary of all the LDP label bindings.
detail	Displays detailed LDP label binding information.
instance <instance-name>	Displays LDP label binding information of the specified instance.
instance <instance-name> <afi>	Displays LDP label binding information of the specified address family. Supported AFI value: l2vpn.
instance <instance-name> <afi> detail	Displays detailed LDP label binding information of the specified address family.
instance <instance-name> <afi> prefix <ip>	Displays LDP label binding information of the specified prefix and instance for the specified address family.
instance <instance-name> <afi> prefix <ip> detail	Displays detailed LDP label binding information of the specified prefix and instance for the specified address family.
received	Displays the LDP received label binding information of the LDP sessions.
received instance <instance-name> <afi>	Displays LDP received label binding information of the specified address family and instance.
received instance <instance-name> <afi> detail	Displays detailed LDP received label binding information of the specified address family and instance.
received instance <instance-name> <afi> ldp-id <ldp-id>	Displays LDP received label binding information of the specified instance.
received instance <instance-name> <afi> ldp-id <ldp-id> detail	Displays detailed LDP received label binding information of the specified LDP identifier and instance.
received <afi>	Displays LDP received label binding information of the specified address family. Supported AFI values: l2vpn.
received <afi> detail	Displays detailed LDP received label binding information of the specified address family.

Option	Description
received <afi> instance <instance-name>	Displays LDP received label binding information of the specified address family and instance.
received <afi> instance <instance-name> detail	Displays detailed LDP received label binding information of the specified address family and instance.
received <afi> instance <instance-name> ldp-id <ldp-id>	Displays LDP received label binding information of the specified address family, instance, and LDP identifier.
received <afi> ldp-id <ldp-id>	Displays LDP received label binding information of the specified address family and LDP identifier.
received <afi> ldp-id <ldp-id> detail	Displays detailed LDP received label binding information of the specified address family and LDP identifier.
sent	Displays the LDP sent label binding information of the LDP sessions.
sent instance <instance-name> <afi>	Displays LDP sent label binding information of the specified address family and instance. Supported AFI values: l2vpn.
sent instance <instance-name> <afi> detail	Displays detailed LDP sent label binding information of the specified address family and instance.
sent instance <instance-name> <afi> prefix <ip>	Displays LDP sent label binding information of the specified address family, instance, and prefix.
sent instance <instance-name> <afi> prefix <ip> detail	Displays detailed LDP sent label binding information of the specified address family, instance, and prefix.
sent <afi>	Displays LDP sent label binding information of the specified address family. Supported AFI values: l2vpn.
sent <afi> detail	Displays detailed LDP sent label binding information of the specified address family.
sent <afi> instance <instance-name>	Displays LDP sent label binding information of the specified address family and instance.
sent <afi> instance <instance-name> detail	Displays detailed LDP sent label binding information of the specified address family and instance.

Option	Description
sent <afi> instance <instance-name> prefix <ip>	Displays LDP sent label binding information of the specified address family, instance, and prefix.
sent <afi> instance <instance-name> prefix <ip> detail	Displays detailed LDP sent label binding information of the specified address family, instance, and prefix
sent <afi> prefix <ip>	Displays LDP sent label binding information of the specified address family and prefix.
sent <afi> prefix <ip> detail	Displays detailed LDP sent label binding information of the specified address family and prefix.

Example: Summary view of the LDP binding

```
supervisor@rtbrick>SPINE01: cfg> show ldp binding
Instance: default, AFI: l2vpn, SAFI: vpls-vpws
  Prefix                                          In Label           Out Label
LDP ID             Status
  00.00.00.00.00.00.00.00.00.00:100/112           -                  label:20002
-                  Best
                                                  label:20002
198.51.100.1:0     Best
  00.00.00.00.00.00.00.00.00.00:200/112           -                  label:20003
-                  Best
                                                  label:20003
198.51.100.1:0     Best
                                                  label:20003        -
198.51.100.5:0     Non-best
```

show ldp route

Syntax:

show ldp route <options>

Option	Description
-	Without any option, this command displays a summary of LDP route information.
instance <instance-name>	Displays LDP route information for the specified instance.

Option	Description
instance <instance-name> <afi>	Displays LDP route information for the specified address family and instance. Supported AFI values: ipv4, ipv6, mpls, l2vpn.
instance <instance-name> ipv4 prefix <ip>	Displays LDP route information for the specified address family of IPv4 prefix and instance.
instance <instance-name> ipv6 prefix <ip>	Displays LDP route information for the specified address family of IPv6 prefix and instance.
instance <instance-name> prefix <ip>	Displays LDP route information for the specified prefix and instance.
instance <instance-name> label <label>	Displays LDP route information for the specified MPLS label and instance.
instance <instance-name> mpls	Displays LDP route information of MPLS labels.
instance <instance-name> mpls label <label>	Displays LDP route information for the specified MPLS label and instance.
label <label>	Displays LDP route information for the specified MPLS label.
ipv4	Displays LDP route information of the IPv4 address family.
ipv4 prefix <ip>	Displays LDP route IPv4 address family information for the specified prefix.
ipv6	Displays LDP route information of the IPv6 address family.
ipv6 prefix <ip>	Displays LDP route IPv6 address family information for the specified prefix.
mpls	Displays LDP route information of MPLS labels.
mpls label <label>	Displays LDP route information for the specified MPLS label.
prefix <ip>	Displays LDP route information for the specified prefix address.

Example: Summary view of the LDP route

```
supervisor@rtbrick>SPINE01: cfg> show ldp route
Instance: default, AFI: l2vpn, SAFI: vpls-vpws
  Prefix                                    Out Label               Next Hop
Interface           Metric
  00.00.00.00.00.00.00.00.00.00:100/112        20002
198.51.100.1                              -                 30000
  00.00.00.00.00.00.00.00.00.00:200/112        20003
198.51.100.1                              -                 30000
```

show ldp l2vpn pseudowire

Syntax:

show ldp l2vpn pseudowire <option>

Option	Description
detail	Displays detailed LDP L2VPN pseudowire information.
instance <name>	Displays pseudowire peer IP information for the specified instance.
instance <name> detail	Displays detailed pseudowire peer IP information for the specified instance.
instance <name> prefix <ip>	Displays pseudowire information for the specified instance and prefix.
instance <name> prefix <ip> detail	Displays detailed pseudowire information for the specified instance and prefix.

Example 1: Display LDP L2VPN pseudowire information for instance default

```
supervisor@rtbrick>SPINE01: cfg> show ldp l2vpn pseudowire
Instance: default, AFI: l2vpn, SAFI: vpls-vpws
  Number of local interfaces: 2
    Peer IP         Interface Name     Prefix                                    Status   PW ID  Pop Label
Push Label
    198.51.100.1    ifl-0/0/17/100     00.00.00.00.00.00.00.00.00.00:100/112     Up       100    label:20002
label:20002
    198.51.100.1    ifl-0/0/17/200     00.00.00.00.00.00.00.00.00.00:200/112     Up       200    label:20003
label:20003
```

Example 2: Display detailed LDP L2VPN pseudowire information for instance default

```
supervisor@rtbrick>SPINE01: cfg> show ldp l2vpn pseudowire instance default detail
Instance: default, AFI: l2vpn, SAFI: vpls-vpws, Number of local interfaces: 8
```

```
  Prefix: 00.00.00.00.00.00.00.00.00.00:1/112
    Peer IP: 198.51.100.1, Interface name: ifl-0/0/17/100
    Pop label: label:519936, Push label: label:519936, Status: Up
    Pseudowire ID: 1, Control word: False
  Prefix: 00.00.00.00.00.00.00.00.00.00:100/112
    Peer IP: 198.51.100.1, Interface name: ifl-0/0/17/200
    Pop label: label:519937, Push label: label:519937, Status: Up
    Pseudowire ID: 100, Control word: True
<...>
```

request switch-over

This command initiates switch tunnelling between primary and backup TLDP neighbors manually.

Syntax:

request switch-over ldp l2vpn instance <instance> **pseudowire** <pseudowire-id>

```
supervisor@rtbrick>SPINE01: cfg> request switch-over ldp l2vpn instance default
pseudowire 100
```

3.4. L2X

3.4.1. Layer 2 Cross-Connect

Overview

L2X (Layer 2 Cross-Connect) is used to directly connect two interfaces at Layer 2, allowing traffic to pass between them without L3 processing. It forwards Ethernet frames between two endpoints without MAC learning, switching, or IP routing. It provides isolated Ethernet connectivity for private line services or interconnecting customer sites.

L2X supports:

- Building point-to-point Ethernet services.
- Extending Layer 2 connectivity between ports.
- Providing transparent VLAN transport.

L2X binds two circuits into a dedicated path that provides traffic isolation. Frames received on one endpoint are forwarded unchanged to the paired endpoint. For remote endpoints, frames are encapsulated (using MPLS) and transported across the provider network. At the egress endpoint, encapsulation is removed and the original frame is delivered. This ensures predictable forwarding.

You can configure L2X locally on a single device or remotely across devices using an underlying transport network.

Types of L2X

L2X has two deployment types:

Local L2X: It creates a direct Layer 2 link between two ports or VLANs on the same router. Data frames move between the interfaces, supporting either unidirectional or bidirectional traffic flow depending on configuration.

The following figure shows a local L2X scenario.

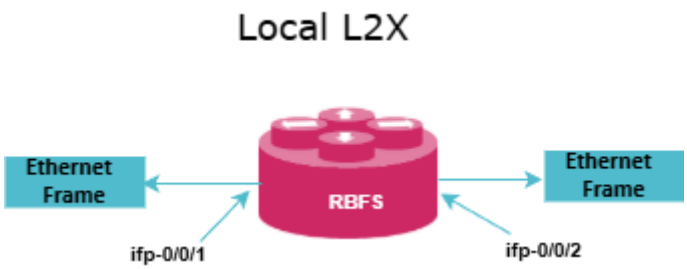


Figure 51. Local L2X

Remote L2X: It establishes a Layer 2 connection between ports on different devices. Each interface resides on a separate router, and an MPLS tunnel carries traffic between them. The two remote devices must be reachable over an MPLS path.

The following figure shows the remote L2X scenario.

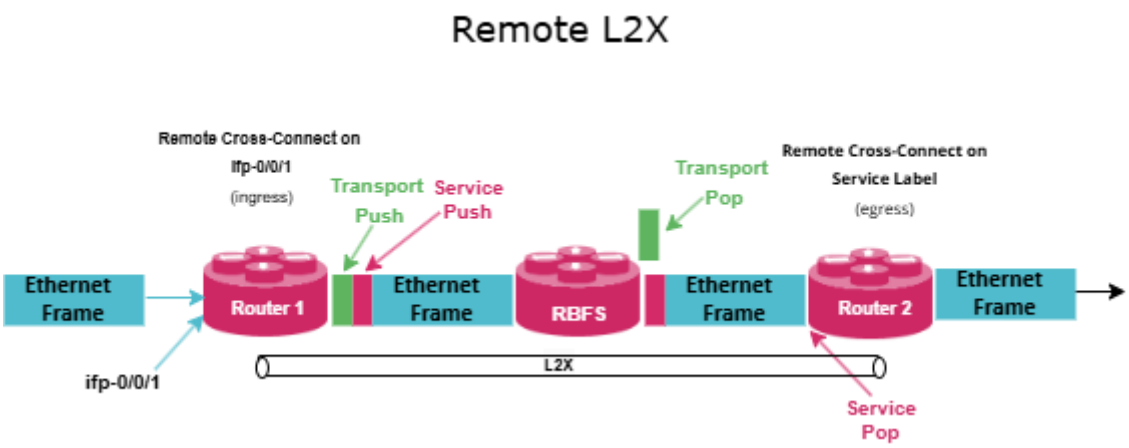


Figure 52. Remote L2X

Traffic Direction

Unidirectional L2X:

Unidirectional indicates data moves in just one direction. For example, traffic flows only from Interface A to Interface B.

Bidirectional L2X:

Traffic flows both directions. For example, traffic flows from Interface A to Interface B and from Interface B to Interface A. You can use L2X to cross-connect two local ports, enabling bidirectional traffic between them. This feature is supported only for local cross-connects.

VLAN operations are NOT supported in bidirectional mode.

Ingress and Egress Traffic in L2X

Ingress refers to traffic entering the network and egress refers to traffic leaving the network.

Port and VLAN-based Cross-Connects

Port and VLAN-based cross-connects (L2X) are used to forward Layer 2 traffic between interfaces. RBFS supports both local and remote cross-connect deployments for port and VLAN modes.

- Port-based cross-connects forward all traffic received on a port, regardless of VLAN tags. This mode operates purely at the port level and does not require VLAN configuration.

- VLAN-based cross-connects forward traffic selectively, based on a specific VLAN identifier.

VLAN Tagging Support

L2X supports multiple VLAN tagging scenarios:

- Single-tagged traffic
- Double-tagged traffic (Q-in-Q) with inner and outer VLAN tags
- Untagged traffic, supported only with port-based cross-connects

VLAN Operations Overview

RBFS supports VLAN manipulation on both ingress and egress interfaces. These operations allow modification of VLAN tags as traffic enters or leaves the device.

Supported VLAN Operations

The following table provides the supported VLAN operations:

VLAN Operation	Description
Single VLAN add	Adds a VLAN tag (802.1Q or 802.1ad) to the frame.
Single VLAN delete	Removes a VLAN tag from the frame.
Outer VLAN swap	Replaces the outer VLAN tag with a new VLAN identifier.

Encapsulation Support

- Supports both the 802.1Q and 802.1ad encapsulations. Default encapsulation is 802.1Q.
- Traffic is matched against both 802.1Q and 802.1ad Ethertypes by default in ingress mode.

Traffic Classification (Match Criteria)

Traffic classification determines how incoming traffic is matched before applying VLAN operations.

On a physical interface (ifp), traffic can be classified using the following match criteria:

Match Criteria	Description
(ifp)	Matches all traffic on the interface (port-based).
(ifp, outer_vlan)	Matches traffic based on the outer VLAN tag.
(ifp, outer_vlan, inner_vlan)	Matches QinQ traffic with specific outer and inner VLAN tags.
(ifp, outer_vlan, any inner_vlan)	Matches traffic with a specific outer VLAN and any inner VLAN.
(ifp, any vlan)	Matches any tagged VLAN traffic on the interface.

Configuration Rules and Restrictions

- Some match criteria are mutually exclusive. For example, (ifp, outer_vlan, inner_vlan) and (ifp, outer_vlan, any inner_vlan) cannot be configured together on the same interface.
- The (ifp, any vlan) match criteria cannot be combined with any other match type on the same interface.
- The match-type attribute must be explicitly configured for:

  match-untagged

  match-any

  match-inner-any

VLAN Change Operation for IFLs

RBFS allows VLAN configurations changes on logical interfaces (IFLs) without removing the existing settings. This feature applies to both Layer 2 and Layer 3 IFLs.

Supported Match Type Validations

The following table lists the supported match type validation options.



- The asterisk * indicates any VLAN or no VLAN tag.
- 'ov' indicates outer vlan and 'iv' indicates inner VLAN.

Cases	Configuration A	Configuration B	Supported
Case 1 : IFP A, *	IFP A,*	IFP A, ov 10	No
	IFP A,*	IFP A, ov 10, iv 20	No
	IFP A,*	IFP A, ov 10, *	No
	IFP A,*	IFP A, untagged	No
Case 2: IFP A, untagged	IFP A, untagged	IFP A, *	No
	IFP A, untagged	IFP A, ov 10	Yes
	IFP A, untagged	IFP A, ov 30, iv 20	Yes
	IFP A, untagged	IFP A, ov 20, *	Yes
Case 3: IFP A, outer_vlan:	IFP A, ov 10	IFP A, *	No
	IFP A, ov 10	IFP A, ov 10, *	No
	IFP A, ov 10	IFP A, ov 20	Yes
	IFP A, ov 10	IFP A, ov 10 , iv 20	No
	IFP A, ov 10	IFP A, ov 40 , iv 7	Yes
	IFP A, ov 10	IFP A, ov 30, *	Yes
	IFP A, ov 10	IFP A, untagged	Yes
Case 4: IFP A, outer_vlan, inner_vlan:	IFP A, ov 10, iv 20	IFP A, *	No
	IFP A, ov 10, iv 20	IFP A, ov 10, *	No
	IFP A, ov 10, iv 20	IFP A, ov 10	No
	IFP A, ov 10, iv 20	IFP A, ov 30	Yes
	IFP A, ov 10, iv 20	FP A, ov 20 , *	Yes
	IFP A, ov 10, iv 20	IFP A, untagged	Yes
	IFP A, ov 10, iv 20	IFP A, ov 10, iv 30	Yes

Cases	Configuration A	Configuration B	Supported
Case 5: IFP A, outer_vlan, *	IFP A, ov 10, *	IFP A, *	No
	IFP A, ov 10, *	IFP A, ov 10	No
	IFP A, ov 10, *	IFP A, ov 10, iv 20	No
	IFP A, ov 10, *	IFP A, ov 20, iv 7	Yes
	IFP A, ov 10, *	IFP A, ov 30	Yes
	IFP A, ov 10, *	IFP A, untagged	Yes
	IFP A, ov 10, *	IFP A, ov 40, *	Yes

Traffic Matching (Match Type)

A match type determines how incoming traffic is recognized and mapped to a particular Layer 2 cross-connect service. The match type specifies which attributes of an incoming packet are examined to associate it with the correct L2X instance.

The supported match type option includes:

Match Type	Description
match-any	Matches all frames, regardless of VLAN tags.
match-inner-any	Matches frames based on the outer VLAN tag, irrespective of the inner VLAN tag.
match-outer	Matches frames based on the outer VLAN tag.
match-outer-inner	Matches frames based on both outer and inner VLAN tags.
match-service-label	Matches frames based on a specific MPLS service label.
match-untagged	Matches frames without any VLAN tags (untagged traffic).

Information About IFL Traffic Statistics

IFL traffic statistics are counters collected on logical interfaces that track the volume of traffic flowing through the interface in ingress and egress directions. Statistics provide visibility into how traffic is handled at the interface level. By default, traffic statistics for Layer 2 IFLs and L2X are disabled. You must explicitly enable statistics using the statistics true command.

- Statistics can be enabled on up to 2048 interfaces, including:

  Layer 2 IFLs

  Layer 3 IFLs

  L2X interfaces

- When QoS is enabled on a Layer 2 or Layer 3 IFL, the interface uses QoS counters and does not count toward the 2048-interface limit.
- After attaching or detaching a QoS profile, you must clear the IFL statistics to ensure accurate counter behavior.
- L2X supports statistics collection for both Ingress direction and Egress direction.
- For static L2X entries, statistics are available for only one direction. Ingress L2X supports ingress statistics only, while egress L2X supports egress statistics only.

L2X Limitations

Bidirectional L2X:

- No VLAN operations supported
- No statistics support

Untagged traffic:

- Only port-based cross-connect is supported.

Supported Platforms

Not all features are necessarily supported on each hardware platform. Refer to the *Platform Guide* for the features and the sub-features that are or are not supported by each platform.

3.4.2. L2X Configuration

Configuration Hierarchy

The diagram illustrates the L2X configuration hierarchy.

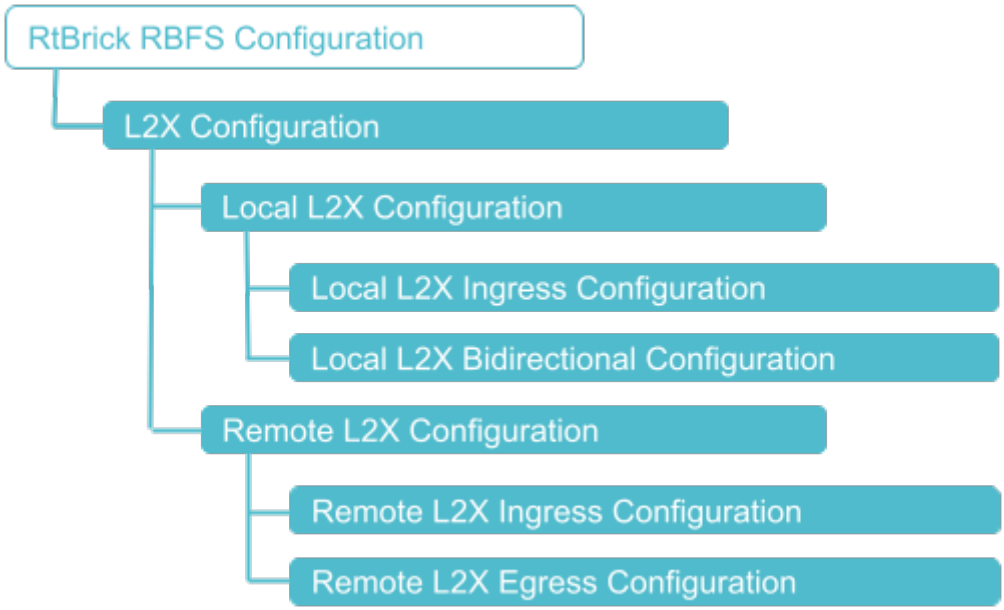


Figure 53. L2X Configuration Hierarchy

Configuration Syntax and Commands

The following sections describe the L2X configuration syntax and commands.

Local L2X Configuration

The following sections describe the Local L2X unidirectional and bidirectional configurations.

Local L2X Ingress Configuration

This configuration enables local unidirectional L2X (Local Cross-Connect) on the same device.

Syntax:

set l2x name <name> [**ingress** | **bi-directional**] **description** <description>
set l2x name <name> [**ingress** | **bi-directional**] **egress-vlan-encapsulation** [**802.1q** | **802.1ad**]
set l2x name <name> [**ingress** | **bi-directional**] **egress-vlan-operation** [**single-vlan-add** | **single-vlan-delete** | **swap-outer-vlan**]
set l2x name <name> [**ingress** | **bi-directional**] **incoming-inner-vlan** <incoming-inner-vlan>
set l2x name <name> [**ingress** | **bi-directional**] **incoming-interface**

<incoming-interface>
set l2x name <name> [**ingress** | **bi-directional**] **incoming-outer-vlan** <incoming-outer-vlan>
set l2x name <name> [**ingress** | **bi-directional**] **ingress-outer-vlan** <ingress-outer-vlan>
set l2x name <name> [**ingress** | **bi-directional**] **ingress-vlan-encapsulation** [**802.1q** | **802.1ad**]
set l2x name <name> [**ingress** | **bi-directional**] **ingress-vlan-operation** [**single-vlan-add** | **single-vlan-delete** | **swap-outer-vlan**]
set l2x name <name> [**ingress** | **bi-directional**] **match-tp-id** [**802.1q** | **802.1ad**]
set l2x name <name> [**ingress** | **bi-directional**] **match-type** [**match-any** | **match-untagged** | **match-inner-any** | **match-outer** | **match-outer-inner** | **match-service-label**]
set l2x name <name> [**ingress** | **bi-directional**] **outgoing-interface** <outgoing-interface>
set l2x name <name> [**ingress** | **bi-directional**] **outgoing-outer-vlan** <outgoing-outer-vlan>
set l2x name <name> [**ingress** | **bi-directional**] **statistics true**

Attribute	Description
<l2x-name>	Name of L2X
description <description>	(Optional) L2X description
egress-vlan-encapsulation <encapsulation>	(Optional) Egress VLAN encapsulation value. NOTE: This option can be configured only after 'swap-outer-vlan' configuration.
egress-vlan-operation <vlan-action>	(Optional) Outgoing VLAN operation
incoming-inner-vlan <vlan-id>	(Optional) Incoming inner VLAN
incoming-interface <incoming-interface>	Incoming physical interface name
incoming-outer-vlan <vlan-id>	(Optional) Incoming outer VLAN

Attribute	Description
ingress-outer-vlan <vlan-id>	(Optional) Outer VLAN at ingress side
ingress-vlan-encapsulation <encapsulation>	(Optional) Ingress VLAN encapsulation value. NOTE: This option can be configured only after 'swap-outer-vlan' configuration.
ingress-vlan-operation <vlan-action>	(Optional) VLAN operation on ingress side outer VLAN
match-type <match-type>	L2X match type
match-tp-id 802.1ad <tpid>	The option enables L2X to recognize and handle packets tagged with 0x88a8/0x8100 TPID, allowing interoperability with 802.1ad/802.1q encapsulated traffic.
outgoing-interface <outgoing-interface>	Outgoing physical interface name
outgoing-outer-vlan <vlan-id>	(Optional) Outgoing outer VLAN
statistics true	Enables (true) L2X statistics. Default: Disabled. For information on guidelines and limitation L2X statistics, see the Guidelines and Limitations section.

Example: Local L2X Ingress Configuration with Port Match

The following configuration creates two local cross-connect (L2X) entries to forward traffic directly between the interfaces ifp-0/0/10 and ifp-0/0/11. One entry handles downstream traffic from ifp-0/0/10 to ifp-0/0/11, while the other handles upstream traffic in the reverse direction. The match-any option ensures that all ingress traffic on the specified interface is forwarded to the configured outgoing interface.

```
set l2x name local_cross_connect_ds ingress
set l2x name local_cross_connect_ds ingress incoming-interface ifp-0/0/10
set l2x name local_cross_connect_ds ingress outgoing-interface ifp-0/0/11
set l2x name local_cross_connect_ds ingress match-type match-any
set l2x name local_cross_connect_us ingress
set l2x name local_cross_connect_us ingress incoming-interface ifp-0/0/11
set l2x name local_cross_connect_us ingress outgoing-interface ifp-0/0/10
set l2x name local_cross_connect_us ingress match-type match-any
```

```
{
  "rtbrick-config:l2x": {
    "name": [
      {
        "name": "local_cross_connect_ds",
        "direction": "ingress",
        "incoming-interface": "ifp-0/0/10",
        "outgoing-interface": "ifp-0/0/11",
        "match-type": "match-any"
      },
      {
        "name": "local_cross_connect_us",
        "direction": "ingress",
        "incoming-interface": "ifp-0/0/11",
        "outgoing-interface": "ifp-0/0/10",
        "match-type": "match-any"
      }
    ]
  }
}
```

Example: Local L2X Ingress VLAN Operations

This configuration defines a local Layer 2 cross-connect for traffic arriving on 'ifp-0/0/10' with outer VLAN 200, forwarding it to ifp-0/0/11. The match condition is based on the outer VLAN (match-outer), ensuring only VLAN 200 traffic is processed. A VLAN operation is applied to add a single outer VLAN tag 400 to the traffic before forwarding.

```
set l2x name local_cross_connect_ds ingress
set l2x name local_cross_connect_ds ingress incoming-interface ifp-0/0/10
set l2x name local_cross_connect_ds ingress incoming-outer-vlan 200
set l2x name local_cross_connect_ds ingress outgoing-interface ifp-0/0/11
set l2x name local_cross_connect_ds ingress match-type match-outer
set l2x name local_cross_connect_ds ingress ingress-vlan-operation single-vlan-add
set l2x name local_cross_connect_ds ingress ingress-outer-vlan 400
```

```
{
  "rtbrick-config:l2x": {
    "name": [
      {
        "name": "local_cross_connect_ds",
        "direction": "ingress",
        "incoming-interface": "ifp-0/0/10",
        "incoming-outer-vlan": 200,
        "outgoing-interface": "ifp-0/0/11",
        "match-type": "match-outer",
        "ingress-vlan-operation": "single-vlan-add",
        "ingress-outer-vlan": 400
      }
    ]
  }
```

```
}
```

This configuration sets up a local Layer 2 cross-connect for traffic received on ifp-0/0/10 with outer VLAN 100, forwarding it to ifp-0/0/11 based on outer VLAN matching. On ingress, the outer VLAN tag is removed (single-vlan-delete), and on egress, the VLAN tag is re-added using a swap operation with VLAN 100 and '802.1ad' encapsulation. This configuration rewrites the VLAN tag while maintaining service delimitation using the specified TPID.

```
set l2x name local_cross_connect_ds ingress incoming-interface ifp-0/0/10
set l2x name local_cross_connect_ds ingress incoming-outer-vlan 100
set l2x name local_cross_connect_ds ingress outgoing-interface ifp-0/0/11
set l2x name local_cross_connect_ds ingress egress-vlan-operation swap-outer-vlan
set l2x name local_cross_connect_ds ingress outgoing-outer-vlan 100
set l2x name local_cross_connect_ds ingress egress-vlan-encapsulation 802.1ad
set l2x name local_cross_connect_ds ingress match-type match-outer
set l2x name local_cross_connect_ds ingress ingress-vlan-operation single-vlan-
delete
set l2x name local_cross_connect_ds ingress match-tp-id 802.1ad
```

```
{
  "rtbrick-config:l2x": {
    "name": [
      {
        "name": "local_cross_connect_ds",
        "direction": "ingress",
        "incoming-interface": "ifp-0/0/10",
        "incoming-outer-vlan": 100,
        "outgoing-interface": "ifp-0/0/11",
        "egress-vlan-operation": "swap-outer-vlan",
        "outgoing-outer-vlan": 100,
        "egress-vlan-encapsulation": "802.1ad",
        "match-type": "match-outer",
        "ingress-vlan-operation": "single-vlan-delete",
        "match-tp-id": "802.1ad"
      }
    ]
  }
}
```

API To access the RESTCONF API that corresponds to this CLI, click here.

Local L2X Bidirectional Configuration

This configuration enables redirecting traffic incoming (ingress) on a particular interface to another interface and vice versa on the same hardware device.

Syntax:

set l2x name <name> **bi-directional match-type** [**match-any** | **match-untagged** | **match-inner-any** | **match-outer** | **match-outer-inner** | **match-service-label**]
set l2x name <name> **bi-directional incoming-interface** <incoming-interface>
set l2x name <name> **bi-directional outgoing-interface** <outgoing-interface>
set l2x name <name> **bi-directional description** <description>
set l2x name <name> **bi-directional egress-vlan-encapsulation** [**802.1q**| **802.1ad**]
set l2x name <name> **bi-directional incoming-inner-vlan** <incoming-inner-vlan>
set l2x name <name> **bi-directional incoming-outer-vlan** <incoming-outer-vlan>
set l2x name <name> **bi-directional ingress-outer-vlan** <ingress-outer-vlan>
set l2x name <name> **bi-directional ingress-vlan-encapsulation** <*802.1q* | **802.1ad**>
set l2x name <name> **bi-directional outgoing-outer-vlan** <outgoing-outer-vlan>
set l2x name <name> **bi-directional statistics true**

Attribute	Description
match-type <match-type>	Match types with which traffic can be matched.
incoming-interface <incoming-interface>	Incoming interface is where the traffic originates from.
outgoing-interface <outgoing-interface>	Outgoing interface where the traffic is going to.
description <description>	(Optional) L2X description
egress-vlan-encapsulation <encapsulation>	(Optional) Egress VLAN encapsulation
incoming-inner-vlan <vlan-id>	(Optional) Incoming inner VLAN
incoming-outer-vlan <vlan-id>	(Optional) Incoming outer VLAN

Attribute	Description
ingress-outer-vlan <vlan-id>	(Optional) Outer VLAN at ingress side
ingress-vlan-encapsulation <encapsulation>	(Optional) Ingress VLAN encapsulation
outgoing-outer-vlan <vlan-id>	(Optional) Outgoing outer VLAN
statistics true	Enables bi-directional traffic statistics collection for this L2X connection. When set to true, the system collects and reports statistics for both directions of traffic.

Example: Local L2X Bidirectional Configuration

This configuration creates a bidirectional local Layer 2 cross-connect between interfaces ifp-0/0/10 and ifp-0/0/11. It forwards traffic in both directions without requiring separate ingress entries for each path. The match-type 'match-untagged' ensures that only untagged traffic is matched and cross-connected between the interfaces.

```
set l2x name local_bidi bi-directional
set l2x name local_bidi bi-directional incoming-interface ifp-0/0/10
set l2x name local_bidi bi-directional outgoing-interface ifp-0/0/11
set l2x name local_bidi bi-directional match-type match-untagged
```

```
{
  "rtbrick-config:l2x": {
    "name": [
      {
        "name": "local_bidi",
        "direction": "bi-directional",
        "incoming-interface": "ifp-0/0/10",
        "outgoing-interface": "ifp-0/0/11",
        "match-type": "match-untagged"
      }
    ]
  }
}
```

Local L2X VLAN Operation Configuration

This configuration enables VLAN operations for both ingress and egress traffic on a particular interface to another interface and vice versa on the same hardware

device.

Syntax:

set l2x name <name> **ingress** [**egress-vlan-operation** | **ingress-vlan-operation**] [**single-vlan-add** | **single-vlan-delete** | **swap-outer-vlan**]

Attribute	Description
<l2x-name>	Name of the l2x.
single-vlan-add	Adds a single VLAN tag to the packet.
single-vlan-delete	Removes a single VLAN tag from the packet.
swap-outer-vlan	Replaces the outer VLAN tag with a new one.

Remote L2X Configuration

The following sections describe the remote L2X configurations.

Remote L2X Ingress Configuration

This configuration enables the remote L2X ingress side.

Syntax:

set l2x name <name> **ingress match-type** [**match-any**| **match-untagged** | **match-inner-any**| **match-outer** | **match-outer-inner** | **match-service-label**]
set l2x name <name> **ingress incoming-interface** <incoming-interface>
set l2x name <name> **ingress ingress-vlan-operation** [**single-vlan-add** | **single-vlan-delete** | **swap-outer-vlan**]
set l2x name <name> **ingress ingress-outer-vlan** <ingress-outer-vlan>
set l2x name <name> **ingress ingress-vlan-encapsulation** [**802.1q** | **802.1ad**]
set l2x name <name> **ingress nexthop4** <nexthop4>
set l2x name <name> **ingress nexthop6** <nexthop6>
set l2x name <name> **ingress lookup-instance** <lookup-instance>
set l2x name <name> **ingress lookup-afi** [**ipv4** | **ipv6** | **mpls**]
set l2x name <name> **ingress lookup-safi** [**labeled-unicast** | **multicast** |

unicast]
set l2x name <name> **ingress service-label** <service-label>
set l2x name <name> **ingress statistics true**

Attribute	Description
match-type <match-type>	Match types with which traffic can be matched. The 'match-type' option includes match-any, match-inner-any, match-outer, match-outer-inner, match-service-label, and match-untagged. For more details, see the Match Type Options section.
incoming-interface <incoming-interface>	Incoming interface is where the traffic originates from.
ingress-vlan-operation <ingress-vlan-action>	(Optional) VLAN operation on ingress side outer VLAN
ingress-outer-vlan <vlan-id>	(Optional) Outer VLAN at ingress side
ingress-vlan-encapsulation <encapsulation>	(Optional) Ingress VLAN encapsulation value
nexthop4/nexthop6 <nexthop>	Next-Hop address
lookup-instance <lookup-instance>	(Optional) Instance name
lookup-afi <lookup-afi>	(Optional) AFI value: IPv4, IPv6, and MPLS.
lookup-safi <lookup-safi>	(Optional) SAFI value: safi values are unicast, labeled-unicast, and multicast.
service-label <service_label>	Service label value.  For details on the supported label ranges, see the undefined/techdocs/current/platform/resource_limit.html#static-system-dynamic-label-ranges[Static, System, and Dynamic Label Ranges] section in the Platform Guide.

Attribute	Description
statistics true	Enables bi-directional traffic statistics collection for this L2X connection. When set to true, the system collects and reports statistics for both directions of traffic.

Example: Remote L2X Ingress Configuration with Port Match

This configuration defines a remote Layer 2 cross-connect for traffic arriving on ifp-0/0/10, forwarding it towards a remote endpoint using the next-hop 198.51.100.44. The forwarding decision is performed via the default routing instance using IPv4 labeled-unicast lookup, with service label 10000 applied for MPLS-based transport. The match-type 'match-any' ensures that all incoming traffic on the interface is processed by this cross-connect.

```
set l2x name remote_l2x ingress incoming-interface ifp-0/0/10
set l2x name remote_l2x ingress nexthop4 198.51.100.44
set l2x name remote_l2x ingress lookup-instance default
set l2x name remote_l2x ingress lookup-afi ipv4
set l2x name remote_l2x ingress lookup-safi labeled-unicast
set l2x name remote_l2x ingress service-label 10000
set l2x name remote_l2x ingress match-type match-any
```

```
{
  "rtbrick-config:l2x": {
    "name": [
      {
        "name": "remote_l2x",
        "direction": "ingress",
        "incoming-interface": "ifp-0/0/10",
        "nexthop4": "198.51.100.44",
        "lookup-instance": "default",
        "lookup-afi": "ipv4",
        "lookup-safi": "labeled-unicast",
        "service-label": 10000,
        "match-type": "match-any"
      }
    ]
  }
}
```

Example: Remote L2X Ingress Configuration with VLAN match

This configuration defines a remote Layer 2 cross-connect for double-tagged traffic received on ifp-0/0/10 with outer VLAN 100 and inner VLAN 200. The traffic is matched using match-outer-inner and forwarded to a remote endpoint via next-

hop 198.51.100.44 using IPv4 labeled-unicast lookup in the default instance. A service label 10000 is applied to enable MPLS-based transport of the matched traffic.

```
set l2x name remote_l2x ingress incoming-interface ifp-0/0/10
set l2x name remote_l2x ingress incoming-outer-vlan 100
set l2x name remote_l2x ingress incoming-inner-vlan 200
set l2x name remote_l2x ingress nexthop4 198.51.100.44
set l2x name remote_l2x ingress lookup-instance default
set l2x name remote_l2x ingress lookup-afi ipv4
set l2x name remote_l2x ingress lookup-safi labeled-unicast
set l2x name remote_l2x ingress service-label 10000
set l2x name remote_l2x ingress match-type match-outer-inner
```

```
{
  "rtbrick-config:l2x": {
    "name": [
      {
        "name": "remote_l2x",
        "direction": "ingress",
        "incoming-interface": "ifp-0/0/10",
        "incoming-outer-vlan": 100,
        "incoming-inner-vlan": 200,
        "nexthop4": "198.51.100.44",
        "lookup-instance": "default",
        "lookup-afi": "ipv4",
        "lookup-safi": "labeled-unicast",
        "service-label": 10000,
        "match-type": "match-outer-inner"
      }
    ]
  }
}
```

Example: Remote L2X Ingress VLAN operations

This configuration defines a remote Layer 2 cross-connect for double-tagged traffic received on ifp-0/0/10 with outer VLAN 100 and inner VLAN 200, using 'match-outer-inner' for classification. The matched traffic has one VLAN tag removed on ingress (single-vlan-delete) before being forwarded to the remote endpoint via next-hop 198.51.100.44 using IPv4 labeled-unicast lookup. A service label 10000 is applied to carry the traffic over MPLS.

```
set l2x name remote_l2x ingress incoming-interface ifp-0/0/10
set l2x name remote_l2x ingress incoming-outer-vlan 100
set l2x name remote_l2x ingress incoming-inner-vlan 200
set l2x name remote_l2x ingress nexthop4 198.51.100.44
set l2x name remote_l2x ingress lookup-instance default
set l2x name remote_l2x ingress lookup-afi ipv4
set l2x name remote_l2x ingress lookup-safi labeled-unicast
set l2x name remote_l2x ingress service-label 10000
```

```
set l2x name remote_l2x ingress match-type match-outer-inner
set l2x name remote_l2x ingress ingress-vlan-operation single-vlan-delete
```

```
{
  "rtbrick-config:l2x": {
    "name": [
      {
        "name": "remote_l2x",
        "direction": "ingress",
        "incoming-interface": "ifp-0/0/10",
        "incoming-outer-vlan": 100,
        "incoming-inner-vlan": 200,
        "nexthop4": "198.51.100.44",
        "lookup-instance": "default",
        "lookup-afi": "ipv4",
        "lookup-safi": "labeled-unicast",
        "service-label": 10000,
        "match-type": "match-outer-inner",
        "ingress-vlan-operation": "single-vlan-delete"
      }
    ]
  }
}
```

Remote L2X Egress Configuration

This configuration enables the remote L2X egress side.

Syntax:

set l2x name <name> **egress outgoing-interface** <outgoing-interface>
set l2x name <name> **egress egress-vlan-operation** [**single-vlan-add** | **single-vlan-delete** | **swap-outer-vlan**]
set l2x name <name> **egress egress-outer-vlan** <egress-outer-vlan>
set l2x name <name> **egress egress-vlan-encapsulation** [**802.1q** | **802.1ad**]
set l2x name <name> **egress service-label** <service-label>
set l2x name <name> **egress statistics true**

Attribute	Description
match-type <match-type>	Match types with which traffic can be matched. The 'match-type' option includes match-any, match-inner-any, match-outer, match-outer-inner, match-service-label, and match-untagged. For more details, see the Match Type Options section.
outgoing-interface <outgoing-interface>	Interface where traffic is going to.
service-label <service_label>	Service label value.  For details on the supported label ranges, see the undefined/techdocs/current/platform/resource_limit.html#static-system-dynamic-label-ranges[Static, System, and Dynamic Label Ranges] section in the Platform Guide.
nexthop4/nexthop6 <nexthop>	Next-Hop address
lookup-instance <lookup-instance>	(Optional) Instance name
lookup-afi <lookup-afi>	(Optional) AFI value: IPv4, IPv6, and MPLS.
lookup-safi <lookup-safi>	(Optional) SAFI value: safi values are unicast, labeled-unicast, and multicast.
egress-vlan-operation <vlan-action>	(Optional) Outgoing VLAN operation.
outgoing-outer-vlan <vlan-id>	(Optional) Outgoing outer VLAN.
statistics true	Enables bi-directional traffic statistics collection for this L2X connection. When set to true, the system collects and reports statistics for both directions of traffic.

Example: Remote L2X Egress Configuration

This configuration defines the egress handling for a remote Layer 2 cross-connect

with service label 10000. Traffic received over MPLS with the matching service label is decapsulated and forwarded to the local interface ifp-0/0/11. This enables proper termination of the remote L2X service on the device.

```
set l2x name remote_l2x egress
set l2x name remote_l2x egress service-label 10000
set l2x name remote_l2x egress outgoing-interface ifp-0/0/11
```

```
{
  "rtbrick-config:l2x": {
    "name": [
      {
        "name": "remote_l2x",
        "direction": "egress",
        "service-label": 10000,
        "outgoing-interface": "ifp-0/0/11"
      }
    ]
  }
}
```

Example: Local L2X Egress Configuration with VLAN Operation

This configuration defines the egress handling for a remote Layer 2 cross-connect with service label 10000, forwarding traffic to ifp-0/0/11. Upon egress, a VLAN tag 400 is added to the traffic using single-vlan-add. This ensures the decapsulated MPLS traffic is properly VLAN-tagged before being transmitted on the outgoing interface.

```
set l2x name remote_l2x egress service-label 10000
set l2x name remote_l2x egress outgoing-interface ifp-0/0/11
set l2x name remote_l2x egress egress-vlan-operation single-vlan-add
set l2x name remote_l2x egress outgoing-outer-vlan 400
```

```
{
  "rtbrick-config:l2x": {
    "name": [
      {
        "name": "remote_l2x",
        "direction": "egress",
        "service-label": 10000,
        "outgoing-interface": "ifp-0/0/11",
        "egress-vlan-operation": "single-vlan-add",
        "outgoing-outer-vlan": 400
      }
    ]
  }
}
```

3.4.3. L2X Operational Commands

The L2X show commands provide detailed information about the L2X operations.

L2X Show Commands

The L2X show commands display data from FIB local table. Therefore, local L2X with down ports or remote l2x with unresolved nexthop address are not displayed.

L2X Details

The show commands display L2X information, including total entry count, entry details, filtered L2X output, and L2X traffic statistics.

Syntax:

show l2x <option>

Option	Description
-	Without any option, the command displays all L2X information such as ingress L2X and egress L2X.
count	Displays the total number of L2X entries.
detail	Displays detailed information for L2X entries.
filter	Displays L2X information based on specified filter criteria.
statistics	Displays L2X traffic statistics.

Example: Summary of total L2X entries

The show l2x count output provides a summary of total L2X entries, ingress and egress, download success and failure status, and the number of L2X mappings between MPLS ports and VLAN ports.

```
supervisor@rtbrick.net: cfg> show l2x count
L2X count
    Total_count                                 : 22
    Ingress_count                               : 12
    Egress_count                                : 10
    Download_success_count                      : 22
    Download_failure_count                      : 0
```

```
    MPLS_port_to_Vlan_port_count                    : 10
    Vlan_port_to_MPLS_port_count                    : 10
```

Example: L2X filter direction

The show l2x filter direction ingress type remote output lists all ingress remote L2X entries, showing their VLAN/service-label mapping, incoming and outgoing interfaces, operational status, and the remote next-hop address.

```
supervisor@rtbrick.net: cfg> show l2x filter direction ingress type remote
Name              Direction    Incoming Intf        Status  Outer VLAN  Inner VLAN   Service label
Outgoing Intf        Status  NextHop
l2bsa_lag_1_101   ingress      lag-1                up      101         -            10001          ifl-
0/0/2/0          up      192.0.2.2
l2bsa_lag_1_111   ingress      lag-1                up      111         -            10011          ifl-
0/0/2/0          up      192.0.2.2
l2bsa_lag_1_121   ingress      lag-1                up      121         -            10021          ifl-
0/0/2/0          up      192.0.2.2
l2bsa_lag_1_131   ingress      lag-1                up      131         -            10031          ifl-
0/0/2/0          up      192.0.2.2
l2bsa_lag_1_141   ingress      lag-1                up      141         -            10041          ifl-
0/0/2/0          up      192.0.2.2
l2bsa_lag_1_201   ingress      lag-1                up      201         -            10201          ifl-
0/0/2/0          up      2001:db8:0:1::2
l2bsa_lag_1_211   ingress      lag-1                up      211         -            10211          ifl-
0/0/2/0          up      2001:db8:0:1::2
l2bsa_lag_1_221   ingress      lag-1                up      221         -            10221          ifl-
0/0/2/0          up      2001:db8:0:1::2
l2bsa_lag_1_231   ingress      lag-1                up      231         -            10231          ifl-
0/0/2/0          up      2001:db8:0:1::2
l2bsa_lag_1_241   ingress      lag-1                up      241         -            10241          ifl-
0/0/2/0          up      2001:db8:0:1::2
```

Example for detailed view of L2X information.

The show l2x detail command displays detailed information for each L2X entry, including direction, download status, VLAN match criteria, interface status and so on.

```
supervisor@rtbrick.net: cfg> show l2x detail
L2X name: IFP-CE1-PE1
  Direction: ingress
  Status: Download success
  Incoming interface: lag-1
  Incoming interface status: up
  Subtype: Incoming Port - Outer Vlan Match
  Incoming outer VLAN: 501
  Incoming inner VLAN: -
  Outgoing interface: ifp-0/0/2
  Outgoing interface status: up
  NextHop:
    NextHop type: Local egress cross connect
    NextHop action: No vlan manipulation - l2 forward
L2X name: IFP-PE1-CE1-501
  Direction: ingress
  Status: Download success
  Incoming interface: ifp-0/0/2
```

```
  Incoming interface status: up
  Subtype: Incoming Port - Outer Vlan Match
  Incoming outer VLAN: 501
  Incoming inner VLAN: -
  Outgoing interface: lag-1
  Outgoing interface status: up
  NextHop:
    NextHop type: Local egress cross connect
    NextHop action: No vlan manipulation - l2 forward
L2X name: l2bsa_lag_1_101
  Direction: ingress
  Status: Download success
  Incoming interface: lag-1
  Incoming interface status: up
  Service label: 10001
  Subtype: Incoming Port - Outer Vlan Match
  Incoming outer VLAN: 101
  Incoming inner VLAN: -
  Outgoing interface: ifl-0/0/2/0
  Outgoing interface status: up
  NextHop:
    NextHop IP: 192.0.2.2
    Lookup instance: default
    Lookup AFI: ipv4
    Lookup SAFI: unicast
    NextHop type: Remote ingress cross connect
    NextHop action: mpls label push
```

L2X Filter

The command displays L2X entries based on filter criteria such as interface, VLAN, next-hop, direction, service label, and so on.

Syntax:

show l2x filter <option>

Option	Description
-	Without any option, displays the L2X filter output using the configured filter criteria.
count	Filters the output by the total L2X entry count.
detail	Displays detailed information for matching L2X entries.
direction	Filters L2X entries by traffic direction.
incoming-interface	Filters L2X entries by the incoming interface name.

Option	Description
inner-vlan	Filters L2X entries by the inner VLAN ID.
<l2x_name>	Filters the output by a specific L2X name.
nexthop4	Filters L2X entries by the remote IPv4 next-hop address.
nexthop6	Filters L2X entries by the remote IPv6 next-hop address.
outer-vlan	Filters L2X entries by the outer VLAN ID.
outgoing-interface	Filters L2X entries by the outgoing interface name.
service-label	Filters L2X entries by the service label value.
type <local | remote>	Filters L2X entries by the L2X type.

API To access the Operational State API that corresponds to this CLI, click here.

Example: Output of L2X Statistics command

The show l2x statistics command output displays ingress and egress traffic counters for the specified L2X, including forwarded and dropped packets and bytes.

```
supervisor@rtbrick.net: cfg> show l2x statistics l2bsa_lag_1_111
L2X Name: l2bsa_lag_1_111
  Ingress
    Counters:
        In-Forward-Packets: 0
        In-Forward-Bytes: 0
        In-Drop-Packets: 0
        In-Drop-Bytes: 0
        Out-Forward-Packets: 0
        Out-Forward-Bytes: 0
        Out-Drop-Packets: 0
        Out-Drop-Bytes: 0
L2X Name: l2bsa_lag_1_111
  Egress
    Counters:
        In-Forward-Packets: 0
        In-Forward-Bytes: 0
        In-Drop-Packets: 0
        In-Drop-Bytes: 0
        Out-Forward-Packets: 0
        Out-Forward-Bytes: 0
        Out-Drop-Packets: 0
        Out-Drop-Bytes: 0
```

Example for the specified service label.

The show l2x filter service-label <label> command displays L2X filter entries matching the specified service label, VLAN match criteria, and interface status.

```
supervisor@rtbrick.net: cfg> show l2x filter service-label 10011
Name               Direction    Incoming Intf        Status  Outer VLAN  Inner
VLAN   Service label   Outgoing Intf        Status  NextHop
l2bsa_lag_1_111    ingress      lag-1                up      111         -
10011           ifl-0/0/2/0          up      192.0.2.2
```

Example for the specified L2X filter type

The show l2x filter type remote command displays the remote L2X filter entries for ingress and egress traffic, including VLAN match criteria, service labels, and interface status.

```
supervisor@rtbrick.net: cfg> show l2x filter type remote
Name               Direction    Incoming Intf        Status  Outer VLAN  Inner
VLAN   Service label   Outgoing Intf        Status  NextHop
l2bsa_lag_1_101    ingress      lag-1                up      101         -
10001           ifl-0/0/2/0          up      192.0.2.2
l2bsa_lag_1_101    egress       -                    -       -           -
20001           lag-1                up      -
l2bsa_lag_1_111    ingress      lag-1                up      111         -
10011           ifl-0/0/2/0          up      192.0.2.2
l2bsa_lag_1_111    egress       -                    -       -           -
20011           lag-1                up      -
l2bsa_lag_1_121    ingress      lag-1                up      121         -
10021           ifl-0/0/2/0          up      192.0.2.2
l2bsa_lag_1_121    egress       -                    -       -           -
20021           lag-1                up      -
l2bsa_lag_1_131    ingress      lag-1                up      131         -
10031           ifl-0/0/2/0          up      192.0.2.2
l2bsa_lag_1_131    egress       -                    -       -           -
20031           lag-1                up      -
l2bsa_lag_1_141    ingress      lag-1                up      141         -
10041           ifl-0/0/2/0          up      192.0.2.2
l2bsa_lag_1_141    egress       -                    -       -           -
20041           lag-1                up      -
l2bsa_lag_1_201    ingress      lag-1                up      201         -
10201           ifl-0/0/2/0          up      2001:db8:0:1::2
l2bsa_lag_1_201    egress       -                    -       -           -
20201           lag-1                up      -
l2bsa_lag_1_211    ingress      lag-1                up      211         -
10211           ifl-0/0/2/0          up      2001:db8:0:1::2
l2bsa_lag_1_211    egress       -                    -       -           -
20211           lag-1                up      -
l2bsa_lag_1_221    ingress      lag-1                up      221         -
10221           ifl-0/0/2/0          up      2001:db8:0:1::2
l2bsa_lag_1_221    egress       -                    -       -           -
20221           lag-1                up      -
l2bsa_lag_1_231    ingress      lag-1                up      231         -
10231           ifl-0/0/2/0          up      2001:db8:0:1::2
```

```
l2bsa_lag_1_231    egress       -                    -       -          -
20231           lag-1               up      -
l2bsa_lag_1_241    ingress      lag-1                up      241        -
10241           ifl-0/0/2/0         up      2001:db8:0:1::2
l2bsa_lag_1_241    egress       -                    -       -          -
20241           lag-1               up      -
```

L2X Hierarchy

The show l2x hierarchy command displays L2X information in a hierarchical format, showing each instance's direction-specific configuration and operational state across both control and forwarding planes.

Syntax:

show l2x hierarchy <l2x_name> **direction** [**ingress** | **egress** | **bi-directional**] <option>

Option	Description
<l2x_name>	Displays the hierarchy for a specific user-defined L2X instance name.
ingress	Displays hierarchies for the traffic entering the router.
egress	Displays hierarchies for the outgoing traffic.
bi-directional	Displays both the Ingress and Egress hierarchies simultaneously.
detail	Provides the detailed information.

The following example output shows the ingress L2X configuration for l2x_local. The information is structured in a hierarchical order for each daemon. It matches traffic on interface 'ifp-0/1/51' with outer VLAN 200 and adding outer VLAN 400. The 'staticd' and 'ribd' sections display the forwarding parameters. The 'fibd' section confirms that the entry is successfully programmed.

```
supervisor@rtbrick.net: op> show l2x hierarchy l2x_local direction ingress
staticd:
  l2x name: l2x_local
  direction: ingress
  incoming ifp: ifp-0/1/51
  incoming outer vlan: 200
  vlan operation: single-vlan-add
  outer vlan: 400
```

```
    nexthop set hash: 88815a358f521438074f8207ea9196c5b17116cbf16ee70f
    nexthop hash: a70e95a94e65f1583a97e086c2c6df72f95e59ed07d981d8
      outgoing ifp: ifp-0/1/52
ribd:
  l2x name: l2x_local
  direction: ingress
  incoming interface: ifp-0/1/51
  incoming outer vlan: 200
  vlan operation: single-vlan-add
  outer vlan: 400
    adjacency set hash: 88815a358f521438074f8207ea9196c5b17116cbf16ee70f
    nexthop hash: a70e95a94e65f1583a97e086c2c6df72f95e59ed07d981d8
      outgoing ifp: ifp-0/1/52
fibd:
  l2x name: l2x_local
  direction: ingress
  incoming interface: ifp-0/1/51
  incoming outer vlan: 200
  vlan operation: single-vlan-add
  outer vlan: 400
    bcm status: Download success
    adjacency set hash: 88815a358f521438074f8207ea9196c5b17116cbf16ee70f
    nexthop hash: a70e95a94e65f1583a97e086c2c6df72f95e59ed07d981d8
      outgoing ifp: ifp-0/1/52
      adjacency status: Success
```

Example for remote L2X hierarchy information

This output displays the hierarchical ingress L2X information for the L2X remote instance. The details include configuration, routing adjacency, and hardware programming state. The 'staticd' and 'ribd' sections show VLAN delete operations and service label association. The 'fibd' section shows that the corresponding adjacencies and service label are successfully programmed in hardware.

```
supervisor@rtbrick.net: op> show l2x hierarchy l2x_remote direction ingress
staticd:
  l2x name: l2x_remote
  direction: egress
    nexthop set hash: b4097df5d61079a99bafd02ed2ab12d9125c02e9e0688b45
    vlan operation: single-vlan-delete
ribd:
  l2x name: l2x_remote
  direction: ingress
  incoming interface: ifp-0/1/51
  incoming outer vlan: 100
  incoming inner vlan: 200
  vlan operation: single-vlan-delete
  service label: 10000
    adjacency set hash: daf65a1cf024de74eb406450cdb4e8e1a163724811158c4e
    nexthop hash: 02c86c766b675e4a693b78ef395a65a1a1c6793e77629142
      nexthop: 100.1.1.1, exit interface: ifl-0/1/51/10
    adjacency set hash: daf65a1cf024de74eb406450cdb4e8e1a163724811158c4e
    nexthop hash: 02c86c766b675e4a693b78ef395a65a1a1c6793e77629142
      nexthop: 100.1.1.1, exit interface: ifl-0/1/52/10
fibd:
  l2x name: l2x_remote
```

```
  direction: egress
    bcm status: Download success
    adjacency set hash: daf65a1cf024de74eb406450cdb4e8e1a163724811158c4e
    adjacency status: Success
    bcm status: Download success
    adjacency set hash: daf65a1cf024de74eb406450cdb4e8e1a163724811158c4e
    adjacency status: Success
    service label: label:10000
```

Example for detailed view of remote L2X hierarchy.

This following example output provides a detailed hierarchical view of the L2X remote ingress instance with in-depth next-hop and lookup information. It shows MPLS label push actions, resolved next-hop attributes, and lookup context details from the RIB.

```
supervisor@rtbrick.net: op> show l2x hierarchy l2x_remote direction ingress detail
staticd:
  l2x name: l2x_remote
  direction: egress
    nexthop set hash: b4097df5d61079a99bafd02ed2ab12d9125c02e9e0688b45
    vlan operation: single-vlan-delete
ribd:
  l2x name: l2x_remote
  direction: ingress
  incoming interface: ifp-0/1/51
  incoming outer vlan: 100
  incoming inner vlan: 200
  vlan operation: single-vlan-delete
  service label: 10000
    adjacency set hash: daf65a1cf024de74eb406450cdb4e8e1a163724811158c4e
    nexthop hash: 02c86c766b675e4a693b78ef395a65a1a1c6793e77629142
      nexthop: 100.1.1.1, exit interface: ifl-0/1/51/10
      nexthop type: Remote ingress cross connect, nexthop action: mpls label push
      lookup instance: default, lookup afi: ipv4, lookup safi: unicast
      mac address: 7a:21:db:c0:00:05
      covering prefix: 100.1.1.1/32
      expanded nexthop: 10.1.1.2
      lookup instance id: 1
    adjacency set hash: daf65a1cf024de74eb406450cdb4e8e1a163724811158c4e
    nexthop hash: 02c86c766b675e4a693b78ef395a65a1a1c6793e77629142
      nexthop: 100.1.1.1, exit interface: ifl-0/1/52/10
      nexthop type: Remote ingress cross connect, nexthop action: mpls label push
      lookup instance: default, lookup afi: ipv4, lookup safi: unicast
      mac address: 7a:21:db:c0:00:06
      covering prefix: 100.1.1.1/32
      expanded nexthop: 20.1.1.2
      lookup instance id: 1
fibd:
  l2x name: l2x_remote
  direction: egress
    bcm status: Download success
    bcm type: MPLS port to Vlan port
    adjacency set hash: daf65a1cf024de74eb406450cdb4e8e1a163724811158c4e
    type: Remote ingress cross connect, action: mpls label push
    adjacency status: Success
```

```
    bcm status: Download success
    bcm type: MPLS port to Vlan port
    adjacency set hash: daf65a1cf024de74eb406450cdb4e8e1a163724811158c4e
    type: Remote ingress cross connect, action: mpls label push
    adjacency status: Success
    service label: label:10000
```

L2X Clear Commands

Clear commands allow to reset operational states.

L2X Statistics

This commands resets L2X statistics for a specified Layer 2 cross connect instance.

Syntax:

clear l2x statistics <l2x-name>

Attribute	Description
<l2x-name>	L2X name.

Example:

```
supervisor@rtbrick: op> clear l2x statistics l2x-test1/0
```

4. Layer 3 Services

4.1. L3VPN

4.1.1. L3VPN Overview

L3VPN, or Layer 3 Virtual Private Network, is a type of MPLS VPN that operates on top of an IP/MPLS transport infrastructure. It allows customers to create secure and private layer 3(IP) connections over a shared infrastructure and provides seamless IP connectivity to the customer's multiple sites.

The key aspects of L3VPN are:

- **IP-Based Routing**: All the control plane communication in the L3VPN network is based on IP-based routing protocols, so there are dynamic updates, multihoming, fault detection, and optimal data routing.
- **Provider Edge (PE)**: The Layer 3 device at the edge of the service provider network is called Provider Edge.
- **Customer Edge (CE)**: The Layer 3 device at the edge of the customer network with its interface connected to the service provider is called the Customer Edge. Both PE and CE have IP connectivity between them, either through Routing Protocols or Static Routing. The PE device has a separate instance configured for each customer. An Instance is a virtual routing and forwarding table (VRF) along with customer-private routing protocols. The CE device is responsible for transferring all the routing information in the customer sites to the PE.
- **Encapsulation and Tunneling**: L3VPN uses the MPLS data plane encapsulation to securely transfer data between two PE routers in the service provider network.
- **VPN Instances**: Each customer has a separate instance (VPN routing and forwarding (VRF)) in PE. This ensures that each customer's data remains separate and maintains data privacy.
- **Security and Privacy**: L3VPN, using the above techniques, such as Encapsulation, Tunneling, and VPN instances, provides isolation for each customer in the shared network.
- **Scalability and Flexibility**: L3VPN supports different network deployments

depending on customer requirements. Instances are deployed only on the Edges, so they can be easily scaled. Filtering based on Extended Communities Route targets provides flexibility at the policy level, so it is possible to create various VPN topologies, such as hub-and-spoke VPNs, etc.

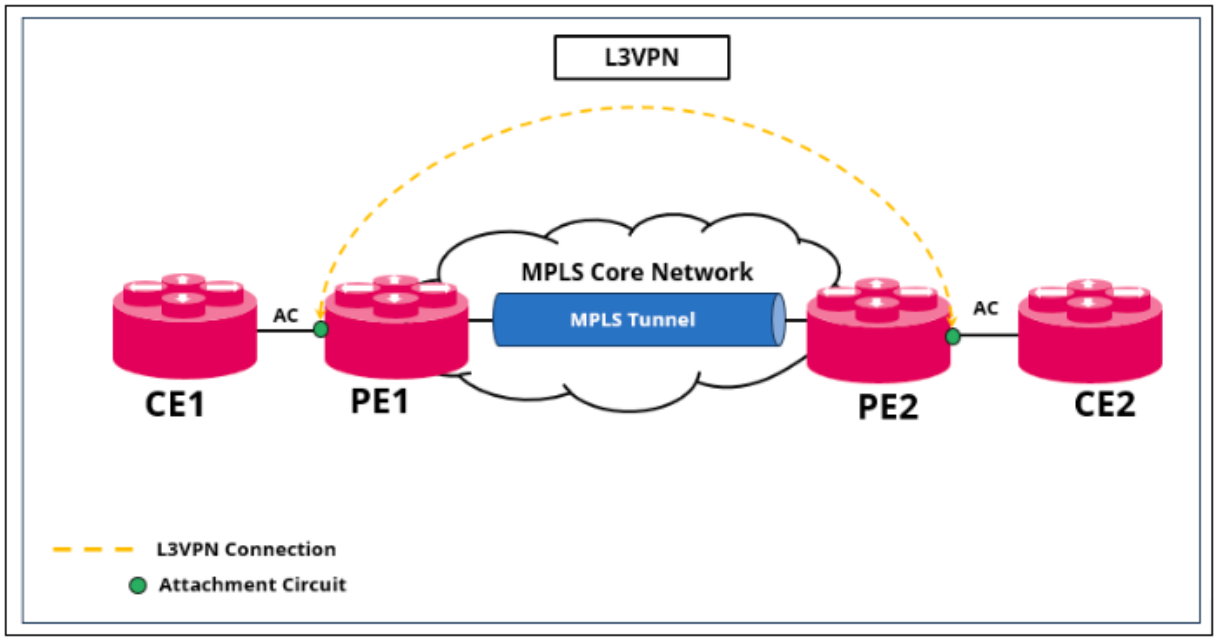


Figure 54. L3VPN Overview

PE1 and PE2 are each configured with a BGP L3VPN instance connected to the customer edge devices (CEs). Both PE and CE have IP connectivity between them, either through Routing Protocols or Static Routing. Once PEs receive customer routes, they use Multi-Protocol BGP (MP-BGP) to exchange the routes between the PEs.

For example, when CE1 needs to transmit packets to CE2, then CE1 initiates a route lookup process to determine the nexthop for getting to CE2. This destination route is exchanged in advance between PEs and CEs through the configured routing protocol. Upon obtaining the routing destination via PEs, the CEs proceed to transmit the packet to PEs. After the PEs receive packets from the CEs, they add the VPN labels which are advertised by the neighboring PEs for the destination route, and send them to the peer PEs using the MPLS label-switched path transport (LSP). After the other PEs receive the packet via the MPLS LSP, they pop the VPN labels of the packets and perform an IP route lookup on the L3VPN instances, and forward the packets to the destination CE2.

Interprovider Layer 3 VPN options

Sometimes, a customer needs an L3 VPN between two locations where a given Service Provider (SP) does not have coverage. To interconnect these customers, Layer 3 VPNs can be deployed in three different ways: Option A, Option B, and Option C.

- **Option A**: When dealing with another ISP, use eBGP, but place the BGP session within the customer's VRF. Essentially, treat the other service provider as if they were just another customer CE. This approach requires each customer's individual BGP and VRF configurations. However, it is ideal when you have no control over the other ISP's network.
- **Option B**: When setting up eBGP with the other ISP, make sure to use the global/default routing table. Each ASBR should advertise a unique label for every destination FEC in every VRF to the other ASBR. This process is similar to creating a label-switched path between the two ISPs.
- **Option C**: Configure eBGP between the ASBRs again, but this time using two planes: 1) The VPN unicast plane for exchanging VPN routes and plane 2 uses BGP Labeled Unicast, which enables PEs in one ISP to establish a label-switched path to the loopbacks of the PEs in the other ISP.

Supported L3VPN Standards

RFC Number	Description
RFC 4364	BGP/MPLS IP Virtual Private Networks (VPNs)

RFC and draft compliance are partial except as specified.

Supported Platforms

Not all features are necessarily supported on each hardware platform. Refer to the *Platform Guide* for the features and the sub-features that are or are not supported by each platform.

4.1.2. L3VPN Configuration

Configuration Hierarchy

The diagram below shows the L3VPN configuration hierarchy.

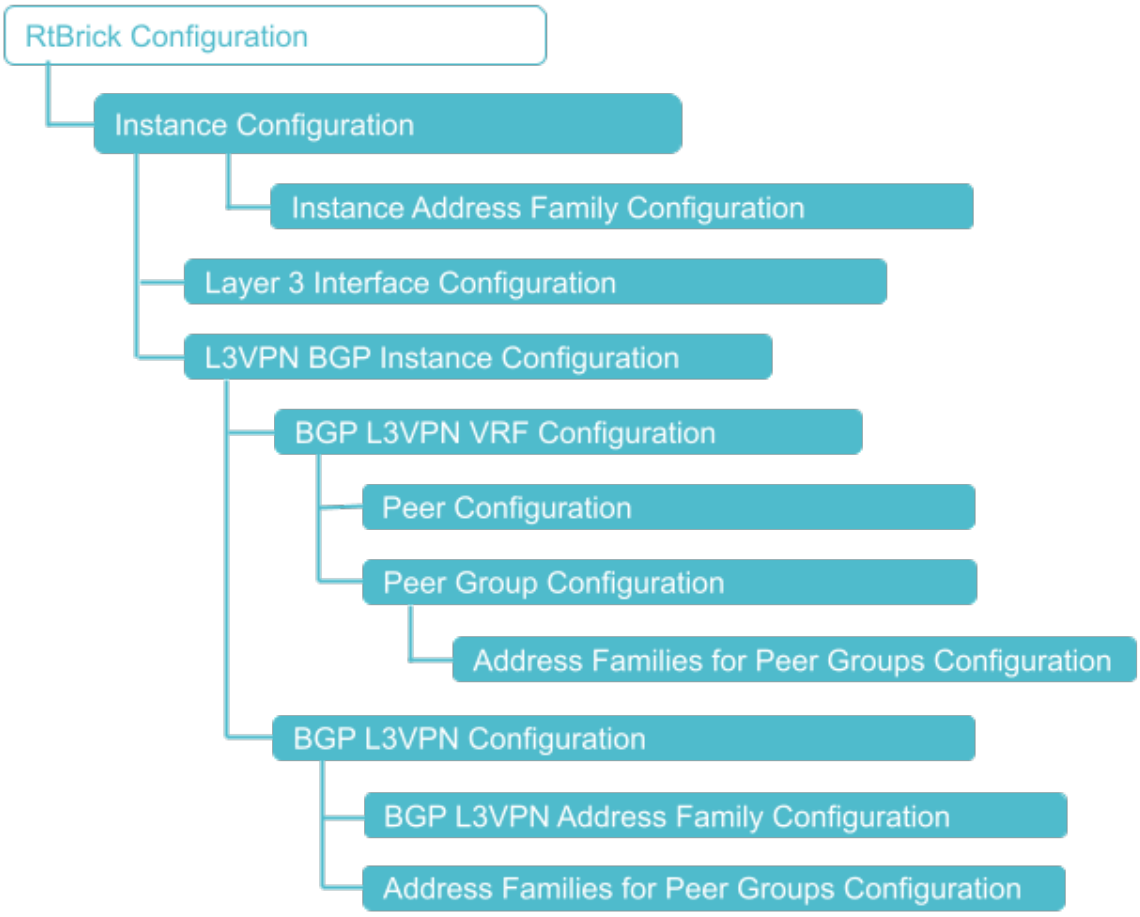


Figure 55. L3VPN Configuration Hierarchy

Configuration Syntax and Commands

The following sections describe the BGP configuration syntax and commands.

Instance Configuration

Each VPN is associated with one or more VPN routing and forwarding (VRF) instances. A VRF defines the VPN membership of a customer site attached to a PE router. A VRF consists of the following components:

- An IP version 4 (IPv4) 6 (IPv6) unicast routing table
- A private FIB table
- A set of interfaces that use the forwarding table

- A set of rules and routing protocol parameters that control the information that is included in the routing table

These components are collectively called a VRF instance.

The instance configuration hierarchy includes parameters that are required for or used by BGP, but that are not part of the BGP protocol configuration hierarchy itself. Route distinguishers and router IDs are configured directly at the instance hierarchy.

Syntax:

set instance <instance-name> <attribute> <value>

Attribute	Description
<instance-name>	Name of the routing instance
route-distinguisher <as-number|ipv4-address:id>	The route distinguisher (RD) uniquely defines routes within an IPv4 network. PE routers use route distinguishers to identify which VPN a packet belongs to. Supported formats are <as-number:id> or <ipv4-address:id>.  If you want to use the format <as-number:id> with a 4-byte ASN, specify it with an "L". For example, set instance services route-distinguisher 4200000000L:101
ipv4-router-id <ipv4-address>	The router ID of the routing instance.

The following example configures tge instance identifier.

```
set instance l3vpn-ce1
set instance l3vpn-ce1 ipv4-router-id 172.16.3.10
set instance l3vpn-ce1 route-distinguisher 172.16.3.10:65001
commit
```

Example: Instance Identifier Configuration

```
supervisor@PE1: cfg> show config instance l3vpn-ce1
{
  "rtbrick-config:instance": [
    {
      "name": "l3vpn-ce1",
      "ipv4-router-id": "172.16.3.10",
      "route-distinguisher": "172.16.3.10:65001",
  <...>
```

Address Families

At the instance address family hierarchy, you can enable or disable address families for the instance, and configure parameters like route targets.

Please note default settings depend on the instance. For the 'default' instance, the IPv4 and IPv6 unicast, multicast, and labeled unicast, as well as the MPLS unicast address families are enabled by default. For any non-default instance, no address family is enabled by default and needs to be enabled by configuration.

Syntax:

set instance <instance-name> **address-family** <afi> <safi> <attribute> <value>

Attribute	Description
<afi>	Address family identifier (AFI). Supported values: ipv4, ipv6
<safi>	Subsequent address family identifier (SAFI). Supported values: unicast

Attribute	Description
route-target (import | export) <rt-value>	Route targets (RT) are used to transfer routes between VPN instances. The RT identifies a subset of routes that should be imported to or exported from a particular VPN instance. You can configure an RT for importing or exporting routes or both.  If you want to use the format <as-number:id> with a 4-byte ASN, specify it with an "L". For example, set instance services address-family ipv4 unicast route-target export target:4200000000L:14
policy (import | export) <policy-name>	There are two attachment points for BGP policies. At this configuration hierarchy, you can attach import or export policies to the instance. These policies apply when routes are imported from the BGP protocol into the instance, or exported from the instance to the BGP protocol.

The following example configures the instance address families.

```
set instance l3vpn-ce1 address-family ipv4 unicast
set instance l3vpn-ce1 address-family ipv4 unicast route-target import
target:172.16.3.10:65001
set instance l3vpn-ce1 address-family ipv4 unicast route-target export
target:172.16.3.10:65001
set instance l3vpn-ce1 address-family ipv6 unicast
set instance l3vpn-ce1 address-family ipv6 unicast route-target import
target:172.16.3.11:65001
set instance l3vpn-ce1 address-family ipv6 unicast route-target export
target:172.16.3.11:65001
commit
```

Example: Instance Address Family Configuration

```
supervisor@PE1: cfg> show config instance l3vpn-ce1 address-family
{
  "rtbrick-config:address-family": [
    {
      "afi": "ipv4",
      "safi": "unicast",
      "route-target": {
        "import": [
          "target:172.16.3.10:65001"
```

```
          ],
        "export": [
          "target:172.16.3.10:65001"
          ]
      }
    },
    {
      "afi": "ipv6",
      "safi": "unicast",
      "route-target": {
        "import": [
          "target:172.16.3.11:65001"
          ],
        "export": [
          "target:172.16.3.11:65001"
          ]
      }
    }
  ]
}
```

Layer 3 Interface Configuration

L3VPN supports the configuration of Layer 3 logical interfaces.

Syntax:

set interface <name> <attribute> <value>

Attribute	Description
unit <unit-id>	Create a logical interface (also referred to as a sub-interface) under the physical interface.
inner-vlan <inner-vlan-id>	Inner VLAN ID.
instance <instance>	Assign the logical interface to an instance.
vlan <outer-vlan-id>	Outer VLAN ID.

The following example shows the interface configuration.

```
set interface ifp-0/0/2 unit 0
set interface ifp-0/0/2 unit 0 instance l3vpn-ce1
set interface ifp-0/0/2 unit 0 address ipv4 10.0.0.1/24
commit
```

Example: Interface Configuration

```
supervisor@PE1: cfg> show config interface ifp-0/0/2
{
  "rtbrick-config:interface": [
    {
      "name": "ifp-0/0/2",
      "unit": [
        {
          "unit-id": 0,
          "instance": "l3vpn-ce1",
          "address": {
            "ipv4": [
              {
                "prefix4": "10.0.0.1/24"
              }
            ]
          }
        }
      ]
    }
  ]
}
```

Interface Address Configuration

This section describes how to configure interface IP addresses.

Syntax:

set interface <interface-name> **unit** <unit-id> **address** <afi> <attribute> <value>

Attribute	Description
<afi>	Address family identifier (AFI). Supported values: ipv4 and ipv6
<prefix4|prefix6>	Assign IPv4 or IPv6 address to the interface unit.

The following show the interface address configuration.

```
set interface ifp-0/0/2 unit 0
set interface ifp-0/0/2 unit 0 instance l3vpn-ce1
set interface ifp-0/0/2 unit 0 address ipv4 10.0.0.1/24
commit
```

Example: Interface Address Configuration

```
supervisor@PE1: cfg> show config interface ifp-0/0/2
{
  "rtbrick-config:interface": [
    {
      "name": "ifp-0/0/2",
      "unit": [
        {
          "unit-id": 0,
          "instance": "l3vpn-ce1",
          "address": {
            "ipv4": [
              {
                "prefix4": "10.0.0.1/24"
              }
            ]
          }
        }
      ]
    }
  ]
}
```

L3VPN BGP Instance Configuration

BGP L3VPN VFT (Virtual Forwarding Table) Configuration

Syntax:

set instance <name> **protocol bgp** <attribute> <value>

Attribute	Description
<name>	Name of the routing instance
host-name <host-name>	The name of the BGP host, to a maximum of 64 characters
domain-name <domain-name>	The name of the BGP routing domain, to a maximum of 64 characters
address-family <afi>	Address family identifier (AFI). Supported value: ipv4, ipv6
address-family <afi> <safi>	Subsequent address family identifier (SAFI). Supported value: unicast
local-as <as-number>	The AS number in four-byte format. The numbers allowed are from 1 to 4294967295.

Attribute	Description
med <med-value>	The BGP Multi-Exit Discriminator (MED) value. The numbers allowed are from 0 to 4294967295. When an AS has multiple links to another AS, the MED value is used to determine the exit to use to reach the other AS.
router-id <router-id>	Router identifier in IPv4 format
timer hold-time <seconds>	Hold timer in seconds. The valid range is 5 to 65535.
timer keepalive <seconds>	Keep a live timer in seconds. The valid range is 5 to 65535.
redistribute <source>	Enable the redistribution feature to dynamically inject specific types of routes into the BGP protocol. Supported route sources are direct, igmp, ipoe, isis, ospf, pim, ppp, static, and arp-nd.
redistribute <source> policy <policy>	Attach a policy to the redistribution process

The following example configures BGP L3VPN VFT (Virtual Forwarding Table).

```
set instance l3vpn-ce1 protocol bgp domain-name PE1-AS1
set instance l3vpn-ce1 protocol bgp hostname PE1-AS1
set instance l3vpn-ce1 protocol bgp local-as 65001
set instance l3vpn-ce1 protocol bgp router-id 172.16.3.10
set instance l3vpn-ce1 protocol bgp address-family ipv4 unicast
set instance l3vpn-ce1 protocol bgp address-family ipv6 unicast
commit
```

Example: BGP L3VPN VFT (Virtual Forwarding Table)

```
supervisor@PE1: cfg> show config instance l3vpn-ce1 protocol bgp
{
  "rtbrick-config:bgp": {
    "domain-name": "PE1-AS1",
    "hostname": "PE1-AS1",
    "local-as": 65001,
    "router-id": "172.16.3.10",
    "address-family": [
      {
        "afi": "ipv4",
        "safi": "unicast"
      },
      {
        "afi": "ipv6",
```

```
        "safi": "unicast"
      }
    ],
  <...>
```

Peer Configuration

Once peer groups have been defined, BGP peers can be configured at the peer configuration hierarchy. A peer can be specified by address, or by interface when using IPv6 auto-discovered neighbors and link-local addresses. Furthermore, it is possible to configure TCP authentication and bind it to a peer.

Syntax to configure a BGP peer by address:

set instance <instance-name> **protocol bgp peer** (ipv4 | ipv6) <peer-address> <update-source> **peer-group** <peer-group>

Syntax to configure a BGP peer using IPv6 link-local addresses:

set instance <instance-name> **protocol bgp peer interface** <name> **peer-group** <peer-group>

Syntax to configure TCP Authentication for BGP peers:

set instance <instance-name> **protocol bgp peer** (ipv4 | ipv6) <peer-address> <update-source> **authentication-id** <authentication-id>

Attribute	Description
interface <name>	Enable BGP peer using IPv6 link-local addresses
ipv4 <peer-address>	IPv4 address of a BGP peer
ipv6 <peer-address>	IPv6 address of a BGP peer
allow-as-in <value>	Specify the value for allow-as-in. Allowed range of value 1 - 10.
<update-source>	Local IP address to be used for the peering
peer-group <peer-group>	Assign the peer to a peer group

Attribute	Description
authentication-id <authentication-id>	Authentication identifier

The following example configures a peer.

```
set instance l3vpn-ce1 protocol bgp peer ipv4 10.0.0.9 10.0.0.1
set instance l3vpn-ce1 protocol bgp peer ipv4 10.0.0.9 10.0.0.1 peer-group ce1
commit
```

Example: Peer Configuration

```
supervisor@PE1: cfg> show config instance l3vpn-ce1 protocol bgp peer
{
  "rtbrick-config:peer": {
    "ipv4": [
      {
        "peer-address": "10.0.0.9",
        "update-source": "10.0.0.1",
        "peer-group": "ce1"
      }
    ]
  }
}
```

Peer Group Configuration

In BGP, neighbor peers with the same update policies can be grouped to simplify the initial configuration and updates. Peers share the same policies such as route maps, distribution lists, filter lists, update sources, and so on, so peer groups only need one configuration statement for these values.

Syntax:

set instance <instance-name> **protocol bgp peer-group** <peer-group-name> <attribute> <value>

Attribute	Description
local-as <as-number>	Local AS number for the peer group
remote-as <as-number>	Remote AS number for the peer group
any-as <true|false>	Enable dynamic AS negotiation for this peer group

Attribute	Description
ebgp-multihop <hop-count>	By default, the maximum number of hops between eBGP peers is 1 (direct connection). This hop count overrides the default behavior allowing connectivity between eBGP peers not directly connected.

The following example configures a peer group.

```
set instance l3vpn-ce1 protocol bgp peer-group ce1
set instance l3vpn-ce1 protocol bgp peer-group ce1 remote-as 65009
commit
```

Example: Peer Group Configuration

```
supervisor@PE1: cfg> show config instance l3vpn-ce1 protocol bgp peer-group
{
  "rtbrick-config:peer-group": [
    {
      "pg-name": "ce1",
      "remote-as": 65009,
<...>
```

Configuring Address Families for Peer Groups

At this configuration hierarchy, you can enable the address families that shall be supported for the group peers, and enable features specific to the address family.

Syntax:

set instance <instance-name> **protocol bgp peer-group** <peer-group-name> **address-family** <afi> <safi> <attribute> <value>

Attribute	Description
<afi>	Address family identifier (AFI). Supported values: ipv4, or ipv6
<safi>	Subsequent address family identifier (SAFI). Supported values: unicast `

Attribute	Description
update-nexthop (ipv4-address | ipv6-address) <address>	BGP nexthop address for routes advertised to this peer group
policy (import | export) <policy-name>	Apply a routing policy to the peer group

The following example configures the address families that shall be supported for the group peers

```
set instance l3vpn-ce1 protocol bgp peer-group ce1 address-family ipv4 unicast
set instance l3vpn-ce1 protocol bgp peer-group ce1 address-family ipv6 unicast
commit
```

Example: Peer Groups Address Family Configuration

```
supervisor@PE1: cfg> show config instance l3vpn-ce1 protocol bgp peer-group ce1
address-family
{
  "rtbrick-config:address-family": [
    {
      "afi": "ipv4",
      "safi": "unicast"
    },
    {
      "afi": "ipv6",
      "safi": "unicast"
    }
  ]
}
```

BGP L3VPN Configuration

Configuring the BGP L3VPN Address Families

Syntax:

set instance <name> **protocol bgp address-family** <afi> <safi>

Attribute	Description
<name>	Name of the routing instance

Attribute	Description
<afi>	Address family identifier (AFI). Supported values: ipv4, ipv6
<safi>	Subsequent address family identifier (SAFI). Supported values: vpn-unicast

To configure BGP L3VPN on the default instance, enter the following command:

```
set instance default protocol bgp address-family ipv4 vpn-unicast
set instance default protocol bgp address-family ipv6 vpn-unicast
commit
```

Example: BGP L3VPN Address Family Configuration

```
supervisor@PE1: cfg> show config instance default protocol bgp address-family
{
  "rtbrick-config:address-family": [
    {
      "afi": "ipv4",
      "safi": "vpn-unicast"
    },
    {
      "afi": "ipv6",
      "safi": "vpn-unicast"
    }
  ]
}
```

Configuring Address Families for Peer Groups

Syntax:

set instance <instance-name> **protocol bgp peer-group** <pg-name> **address-family** <afi> <safi> <attribute> <value>

Attribute	Description
<afi>	Address family identifier (AFI). Supported value: ipv4, ipv6.
<safi>	Subsequent address family identifier (SAFI). Supported value: vpn-unicast

Attribute	Description
add-path	Negotiate additional path capabilities with these peers, so that more than one path can be active to the peers in the group
default-information originate <true|false>	Generate and advertise a default route to peers in the group
extended-nexthop	Enable extended-next-hop encoding for BGP peer groups to allow the transfer of IPv4 prefixes over an IPv6 connection
nexthop-self <true|false>	Set the advertised BGP nexthop to yourself, this is the default for eBGP
nexthop-unchanged <true|false>	Do not modify the advertised BGP nexthop, this is the default for iBGP
update-nexthop (ipv4-address | ipv6-address) <address>	BGP nexthop address for routes advertised to this peer group
remove-private-as <true|false>	Remove private AS numbers from routes advertised to group peers
route-reflect-client <true|false>	Configure this peer as a route reflector client
policy (import | export) <policy-name>	Apply a routing policy to the peer group

To configure BGP L3VPN Peer Group on the default instance, enter the following command:

```
set instance default protocol bgp peer-group PE2-AS1 address-family ipv4 vpn-
unicast
set instance default protocol bgp peer-group PE2-AS1 address-family ipv6 vpn-
unicast
commit
```

Example: Configuring Address Families for Peer Groups

```
supervisor@PE1: cfg> show config instance default protocol bgp peer-group PE2-AS1
{
  "rtbrick-config:peer-group": [
    {
      "pg-name": "PE2-AS1",
```

```
      "remote-as": 4200000001,
      "address-family": [
        {
          "afi": "ipv4",
          "safi": "vpn-unicast"
        },
        {
          "afi": "ipv6",
          "safi": "vpn-unicast"
        }
      ]
    }
  ]
}
```

4.1.3. L3VPN Operational Commands

L3VPN Show Commands

BGP Summary

This command displays BGP protocol parameters like attributes or timers that are generic to the BGP instance.

Syntax:

show bgp summary <option>

Attribute	Description
Option	Description
-	Without any option, the command displays the information for all instances.
instance <instance-name>	BGP summary information for the given instance.

Example 1: BGP summary for L3VPN VRF instance

```
supervisor@rtbrick: op> show bgp summary instance l3vpn-ce1
Instance: l3vpn-ce1
  General information
    Hostname: PE1, Domain name: PE1
    Local AS: 65001, Version: 4
    Local preference: 100, eBGP Protocol preference: 20, iBGP Protocol preference: 200
    Router ID: 172.16.3.10, Cluster ID: 172.16.3.10
    MED: 0, Enforce first AS: True
    Address families configured:
```

```
      ipv4: unicast
      ipv6: unicast
  Capabilities
    Route refresh: True, AS4: True, Graceful restart: False,
  Best route selection
    Always compare MED: False, Ignore as path: False
    Ignore local preference: False, Ignore origin: False
    Ignore MED: False, Ignore route source: False
    Ignore router ID: False, Ignore uptime: True
    Ignore cluster length: False, Ignore peer IP: False
    Route select parameter: 0
  Timers
    Connect retry: 30s, Keepalive: 30s, Holdtime: 90s
  Statistics
    Peers configured: 1, Peers auto discovery: 0
      Peers in idle          : 0
      Peers in connect       : 0
      Peers in active        : 0
      Peers in opensent      : 0
      Peers in openconfirm   : 0
      Peers in established   : 1
```

Example 2: BGP summary for L3VPN default instance

```
supervisor@rtbrick: op> show bgp summary instance default
Instance: default
  General information
    Hostname: PE1, Domain name: PE1-BGP-Peers
    Local AS: 4200000001, Version: 4
    Local preference: 100, eBGP Protocol preference: 20, iBGP Protocol preference: 200
    Router ID: 192.168.0.20, Cluster ID: 192.168.0.20
    MED: 0, Enforce first AS: True
    Address families configured:
      ipv4: vpn-unicast
      ipv6: vpn-unicast
  Capabilities
    Route refresh: True, AS4: True, Graceful restart: False,
  Best route selection
    Always compare MED: False, Ignore as path: False
    Ignore local preference: False, Ignore origin: False
    Ignore MED: False, Ignore route source: False
    Ignore router ID: False, Ignore uptime: True
    Ignore cluster length: False, Ignore peer IP: False
    Route select parameter: 0
  Timers
    Connect retry: 30s, Keepalive: 30s, Holdtime: 90s
  Statistics
    Peers configured: 1, Peers auto discovery: 0
      Peers in idle          : 0
      Peers in connect       : 0
      Peers in active        : 0
      Peers in opensent      : 0
      Peers in openconfirm   : 0
      Peers in established   : 1
```

BGP Peer

The 'show bgp peer' commands display information on BGP peers.

Syntax:

```
show bgp peer <option>
```

Option	Description
-	Without any option, the commands display all BGP peers in all instances in a summary table format.
detail	Detailed information on all BGP peers in all instances in a list view.
<peer-name>	Detailed information on the peer with the given name.
address <peer-address>	Detailed information on the peer with the given IP address.
history	Displays BGP peer history information such as the peer state down reasons.
history <peer-address>	Displays BGP peer history information such as the peer state down reasons for a specified peer.
instance <instance-name>	Summary of all BGP peers in the given instance.
instance <instance-name> detail	Detailed information on all BGP peers in the given instance.
instance <instance-name> detail <peer-name>	Detailed information on the peer with the given name in the given instance.
instance <instance-name> detail address <peer-address>	Detailed information on the peer with the given IP address in the given instance.
statistics	Received and sent BGP prefixes per AFI/SAFI for all peers in all instances.
statistics peer <peer-name>	Received and sent BGP prefixes per AFI/SAFI for the peer with the given name.
statistics peer address <peer-address>	Received and sent BGP prefixes per AFI/SAFI for the peer with the given IP address.
statistics instance <instance-name> peer <peer-name>	Received and sent BGP prefixes per AFI/SAFI for the peer with the given name in the given instance.

Option	Description
statistics instance <instance-name> peer address <peer-address>	Received and sent BGP prefixes per AFI/SAFI for the peer with the given IP address in the given instance.

Example 1: BGP Peer Information for L3VPN VRF instance

```
supervisor@rtbrick: op> show bgp peer instance l3vpn-ce1
Instance: l3vpn-ce1
  Peer                                  Remote AS    State         Up/Down Time              PfxRcvd
PfxSent
  CE1                                   65009        Established   0d:07h:04m:09s            7
14
```

Example 2: BGP Peer Information for L3VPN default instance

```
supervisor@rtbrick: op> show bgp peer instance default
Instance: default
  Peer                                  Remote AS    State         Up/Down Time              PfxRcvd
PfxSent
  PE2                                   4200000002   Established   0d:07h:03m:03s            7
14
```

Example 3: Detailed view of BGP Peer Information for L3VPN VRF instance

```
supervisor@rtbrick: op> show bgp peer instance l3vpn-ce1 detail
Peer: CE1, Peer IP: 10.0.0.9, Remote AS: 65009, Local: 10.0.0.1, Local AS: 65001, Any AS: False
  Type: ebgp, State: Established, Up/Down Time: Thu Dec 05 05:22:33 GMT +0000 2024, Reason: Cease, Sub-Code:
Admin reset
  Discovered on interface: -
  Last transition: Thu Dec 05 05:22:33 GMT +0000 2024, Flap count: 1
  Peer ID        : 172.16.2.10, Local ID  : 172.16.3.10
  Instance       : l3vpn-ce1, Peer group: ce1
  6PE enabled    : False,
  TTL Security   : False, TTL Limit : -
  Timer values:
    Peer keepalive : 30s, Local keepalive: 30s
    Peer holddown  : 90s, Local holddown : 90s
    Connect retry  : 30s
  Timers:
    Connect retry timer : 0s
    Keepalive timer     : expires in 3s 266331us
    Holddown timer      : expires in 1m 26s 901069us
  NLRIs:
    Sent           : ['ipv4-unicast', 'ipv6-unicast']
    Received       : ['ipv4-unicast', 'ipv6-unicast']
    Negotiated     : ['ipv4-unicast', 'ipv6-unicast']
  Capabilities:
    Addpath sent                  : None
    Addpath received              : None
    Addpath negotiated            : None
    Extended nexthop sent         : None
    Extended nexthop received     : None
    Extended nexthop negotiated   : None
    Capabilities:
      Feature                     Sent           Received       Negotiated
      Route refresh               True           True           True
      4 byte AS                   True           True           True
      Graceful restart            False          False          False
      Link local only             False          False          False
  Prefix Limit:
```

```
  End of RIB:
    Address family                Sent                                Received
    IPv4 unicast                  Thu Dec 05 05:22:38 GMT +0000 2024  Thu Dec 05 05:22:38 GMT +0000 2024
    IPv4 labeled-unicast          never                               never
    IPv6 unicast                  Thu Dec 05 05:22:38 GMT +0000 2024  Thu Dec 05 05:22:38 GMT +0000 2024
    IPv6 labeled-unicast          never                               never
    IPv4 VPN-unicast              never                               never
    IPv6 VPN-unicast              never                               never
    IPv4 flowspec                 never                               never
    IPv6 flowspec                 never                               never
    IPv4 VPN-multicast            never                               never
    L2VPN VPLS                    never                               never
    L2VPN EVPN                    never                               never
  RPKI Validation Stats:
    Address family                Valid    Invalid    Unknown
    IPv4 unicast                      0          0          0
    IPv6 unicast                      0          0          0
  Message stats:
    Session stats:
      Direction              Open          Update       Keepalive          Notify   Route refresh
      Input                     1               4            1035               0               0
      Output                    1               9            1032               0               0
    Total stats:
      Input                     2               8            1101               0               0
      Output                    3              11            1097               1               0
    Route stats:
      Address family                        Received            Sent    Prefix limit    Idle timeout
      IPv4 unicast                                 4               4               0               0
      IPv4 labeled-unicast                         0               0               0               0
      IPv6 unicast                                 3               3               0               0
      IPv6 labeled-unicast                         0               0               0               0
      IPv4 VPN-unicast                             0               0               0               0
      IPv6 VPN-unicast                             0               0               0               0
      IPv4 VPN-multicast                           0               0               0               0
      L2VPN VPLS                                   0               0               0               0
      L2VPN EVPN                                   0               0               0               0
      IPv4 flowspec                                0               0               0               0
      IPv6 flowspec                                0               0               0               0
```

Example 4: Detailed view of BGP Peer Information for L3VPN default instance

```
supervisor@rtbrick: op> show bgp peer instance default detail
Peer: PE2, Peer IP: 192.168.0.30, Remote AS: 4200000002, Local: 192.168.0.20, Local AS: 4200000001, Any AS:
False
  Type: ebgp, State: Established, Up/Down Time: Thu Dec 05 05:24:03 GMT +0000 2024
  Discovered on interface: -
  Last transition: Thu Dec 05 05:24:03 GMT +0000 2024, Flap count: 0
  Peer ID        : 192.168.0.30, Local ID  : 192.168.0.20
  Instance       : default, Peer group: PE2
  6PE enabled    : False,
  TTL Security   : False, TTL Limit : -
  Timer values:
    Peer keepalive : 30s, Local keepalive: 30s
    Peer holddown  : 90s, Local holddown : 90s
    Connect retry  : 30s
  Timers:
    Connect retry timer : 0s
    Keepalive timer     : expires in 15s 663139us
    Holddown timer      : expires in 1m 15s 207239us
  NLRIs:
    Sent           : ['ipv4-vpn-unicast', 'ipv6-vpn-unicast']
    Received       : ['ipv4-vpn-unicast', 'ipv6-vpn-unicast']
    Negotiated     : ['ipv4-vpn-unicast', 'ipv6-vpn-unicast']
  Capabilities:
    Addpath sent                  : None
    Addpath received              : None
    Addpath negotiated            : None
    Extended nexthop sent         : None
    Extended nexthop received     : None
    Extended nexthop negotiated   : None
    Capabilities:
      Feature                     Sent            Received        Negotiated
      Route refresh               True            True            True
```

```
      4 byte AS                   True            True            True
      Graceful restart            False           False           False
      Link local only             False           False           False
  Prefix Limit:
  End of RIB:
    Address family                Sent                                Received
    IPv4 unicast                  never                               never
    IPv4 labeled-unicast          never                               never
    IPv6 unicast                  never                               never
    IPv6 labeled-unicast          never                               never
    IPv4 VPN-unicast              Thu Dec 05 05:24:08 GMT +0000 2024  Thu Dec 05 05:24:08 GMT +0000 2024
    IPv6 VPN-unicast              Thu Dec 05 05:24:08 GMT +0000 2024  Thu Dec 05 05:24:08 GMT +0000 2024
    IPv4 flowspec                 never                               never
    IPv6 flowspec                 never                               never
    IPv4 VPN-multicast            never                               never
    L2VPN VPLS                    never                               never
    L2VPN EVPN                    never                               never
  Message stats:
    Session stats:
      Direction              Open          Update       Keepalive          Notify   Route refresh
      Input                     1               9            1033               0               0
      Output                    1               4            1035               0               0
    Total stats:
      Input                     1               9            1033               0               0
      Output                    2               4            1035               0               0
    Route stats:
      Address family                       Received            Sent    Prefix limit    Idle timeout
      IPv4 unicast                                0               0               0               0
      IPv4 labeled-unicast                        0               0               0               0
      IPv6 unicast                                0               0               0               0
      IPv6 labeled-unicast                        0               0               0               0
      IPv4 VPN-unicast                            4               4               0               0
      IPv6 VPN-unicast                            3               3               0               0
      IPv4 VPN-multicast                          0               0               0               0
      L2VPN VPLS                                  0               0               0               0
      L2VPN EVPN                                  0               0               0               0
      IPv4 flowspec                               0               0               0               0
      IPv6 flowspec                               0               0               0               0
```

BGP RIB-in

This command displays the received routes.

Syntax:

show bgp rib-in <option>

Option	Description
-	Without any option, the command displays information on the received BGP routing table on all instances in a summary table format.
<afi>	BGP routing table summary for the given address family (AFI), all sub-address families and all instances. Supported AFI values are 'ipv4', 'ipv6' and 'l2vpn'.

Option	Description
<afi> <safi>	BGP routing table summary for the given address family (AFI) and sub-address family (SAFI), and all instances. Supported SAFI values are 'evpn', 'labeled-unicast', 'unicast', 'vpn-multicast', 'vpn-unicast', and 'vpls'.
<afi> <safi> detail	Detailed list view of the BGP routing table for the given address family (AFI) and sub-address family (SAFI), and all instances.
<afi> <safi> <prefix>	BGP routing table entry for the given prefix and all instances.
<afi> <safi> instance <instance-name>	BGP routing table summary for the given AFI, SAFI, and instance.
<afi> <safi> instance <instance-name> detail	Detailed list view of BGP routing table for the given AFI, SAFI, and instance.
<afi> <safi> instance <instance-name> <prefix>	BGP routing table entry for the given prefix and instance.
<afi> <safi> community <community-name>	BGP community details for the given AFI, SAFI, and instance.
<afi> <safi> error	BGP route with error status for the given AFI, SAFI, and instance.
<afi> <safi> peer <name> / peer address <ip>	Peer name or address

Example 1: Summary view of the BGP rib-in where you can find received information for the L3VPN VRF instance l3vpn-ce1 of IPv4 prefixes.

```
supervisor@rtbrick: op> show bgp rib-in ipv4 unicast
Flags: & - Imported, ! - Error, N - RPKI Unknown, I - RPKI Invalid, V - RPKI Valid
Instance: l3vpn-ce1, AFI: ipv4, SAFI: unicast
  Hostname: ce1, Peer IP: 10.0.0.9
  Source IP: 10.0.0.1, Total routes: 4
    Flags  Prefix                                  Next Hop                        MED         Lpref
AS Path
           10.0.0.0/24                             10.0.0.9                        0           -
65009
           172.16.2.10/32                          10.0.0.9                        0           -
65009
           172.16.2.11/32                          10.0.0.9                        0           -
65009
           172.16.2.12/32                          10.0.0.9                        0           -
65009
```

Example 2: Summary view of the BGP rib-in where you can find received information for the L3VPN VRF instance l3vpn-ce1 of IPv6 prefixes.

```
supervisor@rtbrick: op> show bgp rib-in ipv6 unicast
Flags: & - Imported, ! - Error, N - RPKI Unknown, I - RPKI Invalid, V - RPKI Valid
Instance: l3vpn-ce1, AFI: ipv6, SAFI: unicast
  Hostname: ce1, Peer IP: 10.0.0.9
  Source IP: 10.0.0.1, Total routes: 3
    Flags  Prefix                                   Next Hop                        MED         Lpref
AS Path
           172:16:2::10/128                         10.0.0.9                        0           -
65009
           172:16:2::11/128                         10.0.0.9                        0           -
65009
           172:16:2::12/128                         10.0.0.9                        0           -
65009
supervisor@S1-STD-1-1011>bm13-tst.fsn.rtbrick.net: op>
```

Example 3: Summary view of the BGP rib-in where you can find received information of L3VPN default instance of address-family IPv4 vpn-unicast

```
supervisor@rtbrick: op> show bgp rib-in ipv4 vpn-unicast
Flags: & - Imported, ! - Error, N - RPKI Unknown, I - RPKI Invalid, V - RPKI Valid
Instance: default, AFI: ipv4, SAFI: vpn-unicast
  Hostname: PE2, Peer IP: 192.168.0.30
  Source IP: 192.168.0.20, Total routes: 4
    Flags  Prefix                                   Next Hop                        MED         Lpref
AS Path
           10.0.1.0/24                              192.168.0.30                    0           -
4200000002, 65029
           172.16.2.20/32                           192.168.0.30                    0           -
4200000002, 65029
           172.16.2.21/32                           192.168.0.30                    0           -
4200000002, 65029
           172.16.2.22/32                           192.168.0.30                    0           -
4200000002, 65029
```

Example 4: Summary view of the BGP rib-in where you can find received information of L3VPN default instance of address-family IPv6 vpn-unicast

```
supervisor@rtbrick: op> show bgp rib-in ipv6 vpn-unicast
Flags: & - Imported, ! - Error, N - RPKI Unknown, I - RPKI Invalid, V - RPKI Valid
Instance: default, AFI: ipv6, SAFI: vpn-unicast
  Hostname: PE2, Peer IP: 192.168.0.30
  Source IP: 192.168.0.20, Total routes: 3
    Flags  Prefix                                   Next Hop                        MED         Lpref
AS Path
           172:16:2::20/128                         192.168.0.30                    0           -
4200000002, 65029
           172:16:2::21/128                         192.168.0.30                    0           -
4200000002, 65029
           172:16:2::22/128                         192.168.0.30                    0           -
4200000002, 65029
```

BGP FIB

The 'show bgp fib' commands display the BGP forwarding table.

Syntax:

show bgp fib <option>

Option	Description
-	Without any option, the commands display the BGP forwarding table for all address families and all instances in a summary table format.
<afi>	BGP forwarding table summary for the given address family (AFI), all sub-address families and all instances. Supported AFI values are 'l2vpn', 'ipv4' and 'ipv6'.
<afi> <safi>	BGP forwarding table summary for the given address family (AFI) and sub-address family (SAFI), and all instances. Supported SAFI values are 'unicast', 'labeled-unicast', 'vpn-multicast', 'vpn-unicast', 'evpn-vpws', and 'vpls-vpws'.
<afi> <safi> detail	Detailed list view of the BGP forwarding table for the given address family (AFI) and sub-address family (SAFI), and all instances.
<afi> <safi> <prefix>	BGP forwarding table entry for the given prefix and all instances.
<afi> <safi> instance <instance-name>	BGP forwarding table summary for the given AFI, SAFI, and instance.
<afi> <safi> instance <instance-name> detail	Detailed list view of BGP forwarding table for the given AFI, SAFI, and instance.
<afi> <safi> instance <instance-name> <prefix>	BGP forwarding table entry for the given prefix and instance.

Example: Summary view of the BGP FIB

```
supervisor@rtbrick: op> show bgp fib
Instance: l3vpn-ce1, AFI: ipv4, SAFI: unicast, Total Routes: 8
  Prefix                                    Preference      Out Label           Next Hop
  10.0.0.0/24                               20              -                   10.0.0.9
  10.0.1.0/24                               20              20001,bos:1         192.168.0.30
  172.16.2.10/32                            20              -                   10.0.0.9
  172.16.2.11/32                            20              -                   10.0.0.9
  172.16.2.12/32                            20              -                   10.0.0.9
  172.16.2.20/32                            20              20001,bos:1         192.168.0.30
```

```
  172.16.2.21/32                           20              20001,bos:1          192.168.0.30
  172.16.2.22/32                           20              20001,bos:1          192.168.0.30
Instance: default, AFI: ipv4, SAFI: vpn-unicast, Total Routes: 8
  Prefix                                   Preference      Out Label            Next Hop
  10.0.0.0/24                              20              20001,bos:1          10.0.0.9
  10.0.1.0/24                              20              20005,bos:1          192.168.0.30
  172.16.2.10/32                           20              20001,bos:1          10.0.0.9
  172.16.2.11/32                           20              20001,bos:1          10.0.0.9
  172.16.2.12/32                           20              20001,bos:1          10.0.0.9
  172.16.2.20/32                           20              20005,bos:1          192.168.0.30
  172.16.2.21/32                           20              20005,bos:1          192.168.0.30
  172.16.2.22/32                           20              20005,bos:1          192.168.0.30
Instance: l3vpn-ce1, AFI: ipv6, SAFI: unicast, Total Routes: 6
  Prefix                                   Preference      Out Label            Next Hop
  172:16:2::10/128                         20              -                    10.0.0.9
  172:16:2::11/128                         20              -                    10.0.0.9
  172:16:2::12/128                         20              -                    10.0.0.9
  172:16:2::20/128                         20              20002,bos:1          192.168.0.30
  172:16:2::21/128                         20              20002,bos:1          192.168.0.30
  172:16:2::22/128                         20              20002,bos:1          192.168.0.30
Instance: default, AFI: ipv6, SAFI: vpn-unicast, Total Routes: 6
  Prefix                                   Preference      Out Label            Next Hop
  172:16:2::10/128                         20              20002,bos:1          10.0.0.9
  172:16:2::11/128                         20              20002,bos:1          10.0.0.9
  172:16:2::12/128                         20              20002,bos:1          10.0.0.9
  172:16:2::20/128                         20              20006,bos:1          192.168.0.30
  172:16:2::21/128                         20              20006,bos:1          192.168.0.30
  172:16:2::22/128                         20              20006,bos:1          192.168.0.30
```

BGP RIB-out

This command displays the routes that were advertised to peers.

Syntax:

show bgp rib-out <option>

Option	Description
-	Without any option, the command displays advertised BGP routes for all instances.
<afi>	BGP routing table summary for the given address family (AFI), all sub-address families and all instances. Supported AFI values are 'l2vpn', 'ipv4' and 'ipv6'.
<afi> <safi>	BGP routing table summary for the given address family (AFI) and sub-address family (SAFI), and all instances. Supported SAFI values are 'evpn', 'unicast', 'labeled-unicast', 'multicast', 'vpn-unicast', and 'vpls'.

Option	Description
<afi> <safi> detail	Detailed list view of the BGP routing table for the given address family (AFI) and sub-address family (SAFI), and all instances.
<afi> <safi> <prefix>	BGP routing table entry for the given prefix and all instances.
<afi> <safi> instance <instance-name>	BGP routing table summary for the given AFI, SAFI, and instance.
<afi> <safi> instance <instance-name> detail	Detailed list view of BGP routing table for the given AFI, SAFI, and instance.
<afi> <safi> instance <instance-name> <prefix>	BGP routing table entry for the given prefix and instance.
<afi> <safi> peer <name> / peer address <ip>	Peer name or address

Example 1: Summary view of the routes advertised to a L3VPN VRF instance peer of IPv4

```
supervisor@rtbrick: op> show bgp rib-out ipv4 unicast
Instance: l3vpn-ce1, AFI: ipv4, SAFI: unicast
  Peer-group: ce1, Sent routes: 8
    Prefix                                    MED     Lpref      Origin          Next Hop
      AS Path
    10.0.0.0/24                               0       -          Incomplete      -
      [65001, 65009]
    10.0.1.0/24                               0       -          Incomplete      -
      [65001, 4200000002, 65029]
    172.16.2.10/32                            0       -          Incomplete      -
      [65001, 65009]
    172.16.2.11/32                            0       -          Incomplete      -
      [65001, 65009]
    172.16.2.12/32                            0       -          Incomplete      -
      [65001, 65009]
    172.16.2.20/32                            0       -          Incomplete      -
      [65001, 4200000002, 65029]
    172.16.2.21/32                            0       -          Incomplete      -
      [65001, 4200000002, 65029]
    172.16.2.22/32                            0       -          Incomplete      -
      [65001, 4200000002, 65029]
```

Example 2: Summary view of the routes advertised to a L3VPN VRF instance peer of IPv6

```
supervisor@rtbrick: op> show bgp rib-out ipv6 unicast
Instance: l3vpn-ce1, AFI: ipv6, SAFI: unicast
  Peer-group: ce1, Sent routes: 6
    Prefix                                    MED     Lpref      Origin          Next Hop
```

```
      AS Path
    172:16:2::10/128                          0       -          Incomplete      -
      [65001, 65009]
    172:16:2::11/128                          0       -          Incomplete      -
      [65001, 65009]
    172:16:2::12/128                          0       -          Incomplete      -
      [65001, 65009]
    172:16:2::20/128                          0       -          Incomplete      -
      [65001, 4200000002, 65029]
    172:16:2::21/128                          0       -          Incomplete      -
      [65001, 4200000002, 65029]
    172:16:2::22/128                          0       -          Incomplete      -
      [65001, 4200000002, 65029]
```

Example 3: Summary view of the routes advertised to L3VPN default instance of address-family IPv4 vpn-unicast

```
supervisor@rtbrick: op> show bgp rib-out ipv4 vpn-unicast
Instance: default, AFI: ipv4, SAFI: vpn-unicast
  Peer-group: PE2, Sent routes: 8
    Prefix                                    MED     Lpref      Origin          Next Hop
      AS Path
    10.0.0.0/24                               0       -          Incomplete      -
      [4200000001, 65009]
    10.0.1.0/24                               0       -          Incomplete      -
      [4200000001, 4200000002, 65029]
    172.16.2.10/32                            0       -          Incomplete      -
      [4200000001, 65009]
    172.16.2.11/32                            0       -          Incomplete      -
      [4200000001, 65009]
    172.16.2.12/32                            0       -          Incomplete      -
      [4200000001, 65009]
    172.16.2.20/32                            0       -          Incomplete      -
      [4200000001, 4200000002, 65029]
    172.16.2.21/32                            0       -          Incomplete      -
      [4200000001, 4200000002, 65029]
    172.16.2.22/32                            0       -          Incomplete      -
      [4200000001, 4200000002, 65029]
```

Example 4: Summary view of the routes advertised to L3VPN default instance of address-family IPv6 vpn-unicast

```
supervisor@rtbrick: op> show bgp rib-out ipv6 vpn-unicast
Instance: default, AFI: ipv6, SAFI: vpn-unicast
  Peer-group: PE2, Sent routes: 6
    Prefix                                    MED     Lpref      Origin          Next Hop
      AS Path
    172:16:2::10/128                          0       -          Incomplete      -
      [4200000001, 65009]
    172:16:2::11/128                          0       -          Incomplete      -
      [4200000001, 65009]
    172:16:2::12/128                          0       -          Incomplete      -
      [4200000001, 65009]
    172:16:2::20/128                          0       -          Incomplete      -
      [4200000001, 4200000002, 65029]
    172:16:2::21/128                          0       -          Incomplete      -
      [4200000001, 4200000002, 65029]
    172:16:2::22/128                          0       -          Incomplete      -
      [4200000001, 4200000002, 65029]
```

5. Subscriber Management

5.1. Subscriber Management

5.1.1. Subscriber Management Overview

RtBrick's modular and scalable subscriber management, referred to as next-generation access infrastructure (ng-access), supports a range of access protocols including PPPoE, L2TPv2, IPoE (DHCPv4/v6), and RADIUS. This system is designed to deliver carrier-grade internet access services, with a focus on scalability, interoperability, and robustness. By providing support for multiple access protocols, RBFS ensures flexibility in deployment and compatibility with various network configurations, which is crucial for operators looking to provide consistent and high-quality services to their customers.

In this context, a subscriber refers to a customer connected through a Broadband Network Gateway (BNG). The BNG manages the connection by handling various protocols and sessions. Each subscriber is associated with a unique MAC address within a VLAN.

Providers that use separate VLANs for different services (e.g. internet and voice) may create multiple independent subscribers for the same customer or household. Although these subscribers might share certain QoS hierarchies, they are otherwise completely independent. Usually, VLANs used for services like IPTV or voice do not require subscriber management using static L3 interfaces with a traditional DHCP relay (non-subscriber).

A subscriber may have different forms of connectivity, depending on the access method used, such as PPPoE or IPoE. Thus, subscriber management involves overseeing customer connections, ensuring proper authentication, authorization, and accounting (AAA) of each subscriber, and maintaining the smooth operation of these sessions within a BNG. Effective subscriber management is key to maintaining high levels of customer satisfaction, as it directly impacts the reliability and performance of the internet services provided.

RBFS supports the following different protocol combinations to tailor an access network:

- **PPPoE Subscriber:** PPPoE/PPP Session and DHCPv6 (Prefix Delegation)

- **L2TP Subscriber:** PPPoE/PPP Session and L2TP Session
- **IPoE Subscriber:** DHCPv4 or DHCPv6

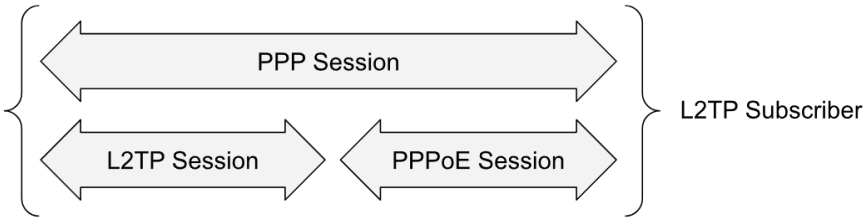


Figure 56. Different Protocol Combinations

RtBrick's implementation utilizes a distributed architecture to enhance both scalability and stability. The distributed nature of this architecture allows multiple processes to manage different aspects of subscriber connections concurrently, reducing bottlenecks and ensuring that the system can handle a large number of subscribers efficiently. Carrier networks often need to interoperate with a wide variety of client devices from different vendors, each requiring adherence to established industry standards and RFCs. This complexity necessitates a robust and flexible approach to managing different network interactions.

Furthermore, these networks must cope with the diverse behaviors of numerous access devices, some of which may have non-standard implementations but cannot be easily replaced due to logistical or cost-related constraints. This adds to the complexity of subscriber management, as non-standard devices may behave unpredictably, requiring additional handling to maintain stable connections. To address these challenges, RBFS provides a protocol stack specifically tailored to offer best-in-class interoperability, ensuring reliable connectivity across a diverse range of client devices. This approach not only ensures that the network can interoperate with devices from various vendors but also allows for customization and adaptation to unique network scenarios.

Overall, RtBrick's subscriber management solution is designed to meet the needs of modern carrier networks by providing a flexible, scalable, and reliable platform for managing customer connections. Its distributed architecture, combined with support for a wide array of protocols and strong adherence to industry standards, makes it well-suited to handle the challenges posed by diverse client environments and evolving network requirements. This ensures that network operators can provide a seamless and high-quality experience to their customers, even in the face of varying device capabilities and non-standard behaviors.

Subscriber Management Daemons

There are four main daemons in the RtBrick distributed access architecture:

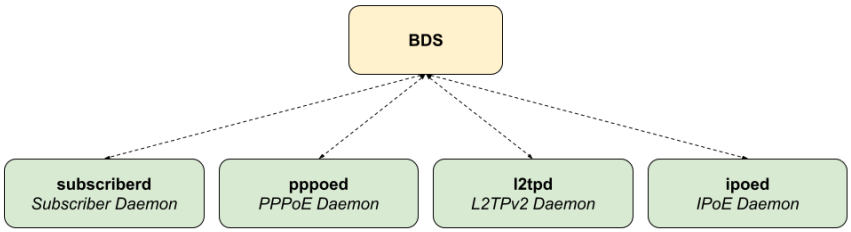


Figure 57. RBFS Access Infrastructure

The subscriber daemon (subscriberd) serves as the central component, managing the current subscriber state and handling Authentication, Authorization, and Accounting (AAA). The roles of each daemon are as follows:

- *subscriberd*: The subscriber daemon is responsible for subscriber management and AAA, which can be performed locally, via RADIUS, or through other methods. It also serves as the interface to the forwarding infrastructure, responsible to request per-subscriber QoS, filters, and more.
- *pppoed*: The PPPoE daemon handles PPPoE and PPP sessions for subscribers including subprotocols as ICMPv6 and DHCPv6 where the implemenation for PPPoE differs compared to IPoE.
- *l2tpd*: The L2TP daemon is responsible to manage L2TPv2 tunnels and sessions.
- *ipoed*: The IPoE (IP-over-Ethernet) daemon handles protocols related to IPoE subscribers like DHCPv4 and DHCPv6.

Subscriber Identifier

Each subscriber in RBFS is uniquely identified by a 64-bit number called subscriber-id, which remains unique across all RBFS processes and even across chassis in the context of high availability.

This uniqueness is achieved through the following format:

- The first 4 bits identify the chassis, starting from 0.
- The next 4 bits identify the process:

  0x00 subscriberd (e.g. L2BSA, test, ...)

0x01 pppoed (PPPoE sessions)

0x02 l2tpd (reserved for LNS)

0x03 ipoed (DHCPv4/v6)

- The following 8 bits are used to identify the application sharding instance. For example, instances such as pppoed.1, pppoed.2, and so on. While currently not in use, these bits provide the ability to partition load across multiple instances of the same process if needed to enhance scalability.
- The remaining 48 bits uniquely identify the subscriber, allowing for up to 281,474,976,710,656 unique subscribers per application instance before repetition, but even in the unlikely case of rollover, RBFS ensures uniqueness.

The subscriber portion always starts at '1', meaning that after a reboot, the subscriber identifiers will begin from the same value. These identifiers are consistent across multiple BNG, unless the chassis-id is explicitly set, which is required only for stateful high-availability configurations. Therefore, this number should not be used as a globally unique, non-repeating identifier in customer databases or management systems.

VLAN Modes and Encapsulations

RBFS supports both 1:1 VLAN (VLAN-per-subscriber) and N:1 VLAN (shared VLAN) models for PPPoE and IPoE subscribers. It supports various VLAN encapsulations. Subscriber VLANs are dynamically created by specifying VLAN ranges with corresponding configurations. After successful authentication, RBFS generates the subscriber IFL, which includes the dynamic VLAN.

1:1 VLAN Model (VLAN-per-subscriber)

In the 1:1 VLAN model, each subscriber is assigned a unique VLAN. This provides a direct one-to-one mapping between VLANs and subscribers. New services can be added easily without affecting others. The 1:1 model is recommended because it is simple and offers flexibility for features like backhauling, bitstream access, and QoS. As a result, more providers are migrating from the N:1 to the 1:1 VLAN model.

The following diagram illustrates a dedicated customer VLAN for each subscriber, showing the one VLAN per subscriber setup.

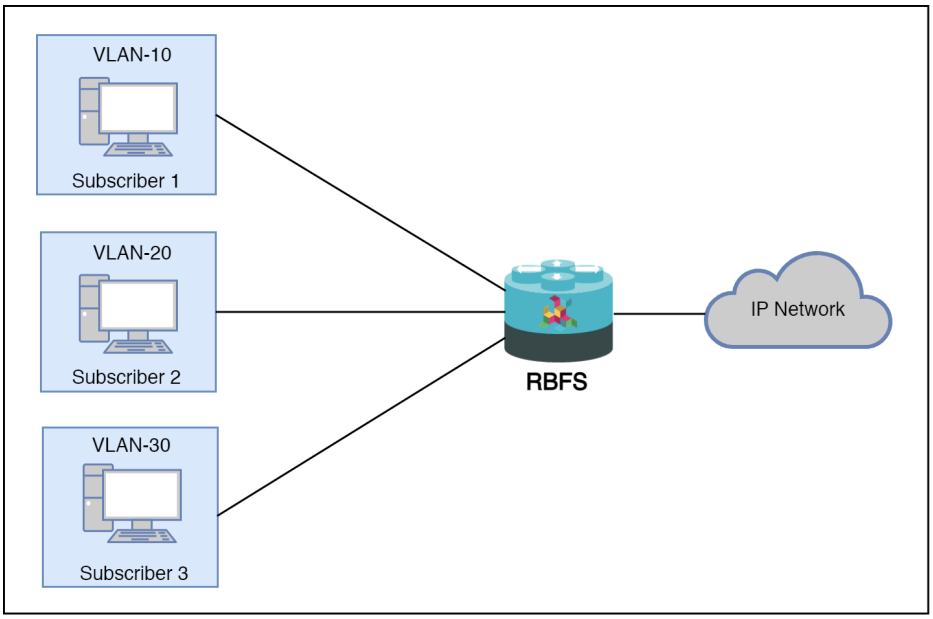


Figure 58. Dedicated Customer VLAN for Each Subscriber

This model is defined by the maximum number of subscribers per VLAN in the access-interface configuration, which has a default value of 1. As a result, the 1:1 VLAN model is also the default in RBFS.

N:1 VLAN Model (shared-VLAN)

The shared VLAN model offers many-to-one (N:1) subscriber-to-service connectivity, where multiple subscribers share a single VLAN. Unlike the 1:1 model, where each subscriber has a dedicated VLAN, the N:1 model provides a shared VLAN for many subscribers. A drawback of the shared VLAN model is the lack of logical isolation between subscribers at the VLAN level.

This results in certain limitations for IPoE subscribers, such as the lack of support for features like HTTP redirect, subscriber ACL, NAT, and IGMP for IPoE N:1 subscribers.

The following diagram shows a single VLAN that is connected to many subscribers.

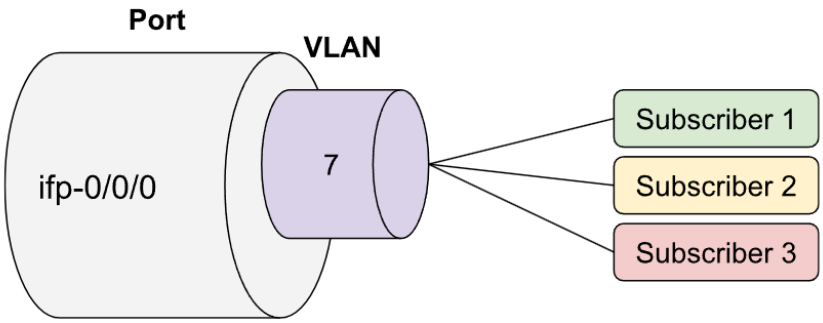


Figure 59. Single VLAN that is Connected to Many Subscribers

This model is defined by the maximum number of subscribers per VLAN in the access-interface configuration, which defaults to 1. Increasing this value beyond 1 enables the N:1 VLAN model for the corresponding access-interface.

Auto-sensing VLAN TPID

In modern telecommunications networks, managing traffic for wholesale partners presents challenges, especially when the network operator lacks knowledge of the specific TPID (Tag Protocol Identifier) used in arriving traffic. This can lead to inefficiencies in network handling and potential service disruptions. To address this issue, RBFS supports Auto-sensing VLAN TPID which automatically detects and processes traffic tagged with different TPIDs. Specifically, this functionality will support both TPID 0x8100, commonly referred to as 802.1q, and TPID 0x88a8, referred to as 802.1ad.

The auto-sensing mechanism will utilize the initial subscriber-initiated packet, such as PPPoE Discovery packets (PADI, PADR), DHCP Discovery, or DHCPv6 Solicit packets, to determine the appropriate TPID. This ensures that the system can adapt to the tagging method used by the incoming traffic without requiring prior knowledge.

The default behavior is auto-sensing the TPID based on the first incoming packet, offering maximum flexibility. However, network operators will still have the option to explicitly define the outer-vlan-encapsulation in the access-interface configuration if required, overriding the auto-sensing functionality when needed. This approach enhances the scalability and efficiency of handling wholesale traffic across various network environments.

This applies to double-tagged profiles only! For single-tagged profiles, the default is 802.1q and cannot be changed, while for untagged profiles, no TPID check is

performed as there is no VLAN present.

Authentication, Authorization, and Accounting Using RADIUS

Remote Authentication Dial-In User Service (RADIUS) is a protocol that provides centralized Authentication, Authorization, and Accounting (AAA) for all types of subscribers. RADIUS servers can perform as authentication and accounting servers. Authentication servers maintain authentication records for subscribers.

The subscriber daemon optionally requests authentication using RADIUS access request messages before permitting subscribers access. Accounting servers handle accounting records for subscribers. The subscriber daemon transmits RADIUS accounting-on, start, interim, and stop messages to the servers. Accounting is the process of tracking subscriber activity and network resource usage in a subscriber session. This includes the session time called time accounting and the number of packets and bytes transmitted during the session called volume accounting. A RADIUS server can behave as a change of authorization (CoA) client, allowing dynamic changes for subscriber sessions. The subscriber daemon supports both RADIUS CoA messages and disconnects messages. CoA messages can modify the characteristics of existing subscriber sessions without loss of service, disconnect messages can terminate subscriber sessions. Each RADIUS request from the subscriber daemon includes the RADIUS accounting-session-id attribute (type 44) with a format that is configurable in the AAA configuration profile and includes at least the subscriber-id to identify the corresponding subscriber. The default format (<subscriber-id>.<timestamp>) includes also a Unix timestamp to ensure that the tuple of NAS-Identifier (e.g. hostname) and Accounting-Session-Id is global and unique to be usable as a key in RADIUS databases.

Additionally, to subscriber-id and accounting-session-id each subscriber consists also of a subscriber-ifl build based on physical port information and subscriber-id (ifp: ifp-0/0/1 and subscriber-id: 72339069014638610 subscriber-ifl: ppp 0/0/1/72339069014638610) which is required as a handle in the RBFS forwarding infrastructure.

```
Code: Access-Request (1)
Packet identifier: 0x22 (34)
Length: 416
Authenticator: e61a0dd74c74704f608688b08de1dfba
[The response to this request is in frame 12]
▼ Attribute Value Pairs
  ▶ AVP: t=User-Name(1) l=19 val=user1@rtbrick.com
  ▶ AVP: t=CHAP-Challenge(60) l=18 val=2f696f4e920b47cab869021feb2bf632
  ▶ AVP: t=CHAP-Password(3) l=19 val=02f439040e9feb7bbc9e7622a364344913
  ▶ AVP: t=NAS-IP-Address(4) l=6 val=1.1.1.1
  ▶ AVP: t=NAS-Identifier(32) l=5 val=BNG
  ▶ AVP: t=NAS-Port-Id(87) l=59 val=BNG#hostif-0/0/4#10#7#0.0.0.0/0.0.0.0 eth 1#DEU.RTBRICK.1
  ▶ AVP: t=NAS-Port(5) l=6 val=67149831
  ▶ AVP: t=NAS-Port-Type(61) l=6 val=Ethernet(15)
  ▶ AVP: t=Service-Type(6) l=6 val=Framed(2)
  ▶ AVP: t=Framed-Protocol(7) l=6 val=PPP(1)
  ▶ AVP: t=Acct-Session-Id(44) l=30 val=72339069014638895:1589876315
  ▶ AVP: t=Vendor-Specific(26) l=13 vnd=RtBrick Inc.(50058)
  ▶ AVP: t=Vendor-Specific(26) l=20 vnd=RtBrick Inc.(50058)
  ▶ AVP: t=Vendor-Specific(26) l=16 vnd=RtBrick Inc.(50058)
  ▶ AVP: t=Vendor-Specific(26) l=25 vnd=RtBrick Inc.(50058)
  ▼ AVP: t=Vendor-Specific(26) l=16 vnd=RtBrick Inc.(50058)
      Type: 26
      Length: 16
      Vendor ID: RtBrick Inc. (50058)
    ▶ VSA: t=RtBrick-Subscriber-Id(25) l=10 val=010100000000012f
  ▼ AVP: t=Vendor-Specific(26) l=35 vnd=RtBrick Inc.(50058)
      Type: 26
      Length: 35
      Vendor ID: RtBrick Inc. (50058)
    ▶ VSA: t=RtBrick-Subscriber-Ifl(26) l=29 val=ppp-0/0/4/72339069014638895
  ▶ AVP: t=Vendor-Specific(26) l=29 vnd=The Broadband Forum(3561)
  ▶ AVP: t=Calling-Station-Id(31) l=23 val=0.0.0.0/0.0.0.0 eth 1
  ▶ AVP: t=Vendor-Specific(26) l=21 vnd=The Broadband Forum(3561)
  ▶ AVP: t=Vendor-Specific(26) l=18 vnd=The Broadband Forum(3561)
```

Figure 60. RADIUS Access-Request



The subscriber-id is an unsigned 64-bit integer which is shown as a hex number in Wireshark.

Each subscriber is formed based on configuration profiles and individual settings retrieved via RADIUS. Conflicts between RADIUS-defined attributes and profile attributes are solved by prioritizing those received from RADIUS which is common best practice for broadband access concentrators. New subscribers are signalled via RADIUS access request and either accepted by RADIUS access-accept or rejected by RADIUS access-reject message from the RADIUS server. The RADIUS access-accept includes all attributes required to form the subscriber like IP addresses, DNS servers, and referenced configuration profiles. Some of those attributes can be changed by RADIUS dynamically using CoA requests without disconnecting the subscriber.

RADIUS Accounting

A RADIUS Acct-Status-Type attribute is used by the RADIUS client (subscriber daemon) to mark the start of accounting (for example, upon booting) by specifying Accounting-On and to mark the end of accounting (for example, just before a scheduled reboot) by specifying Accounting-Off. This message is often used by RADIUS servers to automatically close/terminate all open accounting records/sessions for the corresponding client, and therefore must not be sent to

servers belonging to a profile that was already used/started for accounting.

Per default, the assumption is that all servers referenced by a RADIUS profile share the same states and therefore accounting-on must be only sent to one of those before the first accounting-start is sent.

RADIUS Accounting-On/Off messages are optionally enabled in the RADIUS Profile Configuration using the accounting-on-off attribute. The additional attribute accounting-on-wait prevents any new session until accounting has started meaning that the Accounting-On response is received.



Currently, Accounting-Off is not implemented.

RADIUS accounting requests are often used for billing and therefore should be able to store and retry over a more extended period (commonly up to 24 hours or more) which can be optionally enabled in the RADIUS profile configuration using the accounting-backup attribute. The maximum backup accounting hold time in seconds is defined in the attribute accounting-backup-max.

RADIUS Redundancy

RBFS allows configuring multiple RADIUS authentication and accounting servers for redundancy and or load-balancing. RADIUS redundancy ensures high availability in subscriber authentication, authorization, and accounting services. You can configure multiple RADIUS servers, and when one goes down, another takes over.

The following algorithms are supported:

- **DIRECT (default):** The DIRECT algorithm is designed to primarily focus on **redundancy and fault tolerance**. In this mode, the RBFS subscriber daemon always attempts to send RADIUS requests to a single preferred server. If a response is received, the server continues to be used for subsequent requests. However, if the server becomes unresponsive or times out, the daemon fails over to the next server in the configured list. This process continues sequentially until a server responds or the list of servers is exhausted.
- **ROUND-ROBIN:** The ROUND-ROBIN algorithm implements **load-sharing** across all configured RADIUS servers. Each outgoing RADIUS request is sent to the next server in the list, circularly rotating through the servers. This allows the authentication and accounting load to be spread evenly across all available servers.

RADIUS NAS Port Identifier

RADIUS NAS-Port-id is used to identify the port of a network access router that the subscriber management feature uses to authenticate subscribers.

The RADIUS attribute NAS-Port-Id (87) is formatted such as the following:

```
<NAS-IDENTIFIER>#<IFP>#<OUTER-VLAN>#<INNER-VLAN>#<ACI>#<ARI>
```

The Agent-Circuit-Id (ACI) and Agent-Remote-Id (ARI) are replaced with an empty string (##) if not available.

PPP over Ethernet (PPPoE)

PPP over Ethernet (PPPoE) is the common standard for internet access in the market.

PPPoE Session ID

The PPPoE session ID field is an unsigned 16-bit number as described in RFC2516. The values 0 and 65535 are reserved, with 0 used for PADI/PADO messages and 65535 reserved for future use. The session ID is unique within a broadcast domain (including IFP and VLANs) and for each subscriber device's MAC address. However, it is not unique per device or application instance. The session ID will change each time the session is reconnected.

PPPoE Service Name

When a subscriber device sends a PADI or PADR packet, the packet may include a service name field that specifies a particular service the client is requesting. Though, the system internally ignores the service name from the request, the name is still copied to the response packet sent back to the subscriber device.

If the request does not include any service name, the server's response (PADO or PADS) will include a default service name called access that ensures compatibility with certain clients, such as the Linux 'pppd'.

PPPoE AC-Cookie

This TAG is actually used to aid in protecting against denial-of-service attacks, but it is primarily used in RBFS to decide if a received PADR is a retry for an already

answered (PADS send) one. The value itself is unpredictable and generated securely but it does not protect from reply attacks.

If a client receives this TAG in PADO, it MUST return the TAG unmodified in the following PADR. The TAG_VALUE is binary data of any value and length and is not interpreted by the Host.

The AC-Cookie is generated based on 8-bit salt followed by MD5 hash of salt, client MAC and dynamic PPPoE cookie secret.

```
    0                   1                   2
    0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
    | SALT          | MD5                             |
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

The PPPoE cookie secret is randomly generated during the PPPoE daemon startup.

The AC-Cookie in the PADR creating the session is stored in the PPPoE PPP session object. For any received PADR it can be checked if there is a session on the same broadcast domain (IFP and VLAN's) and MAC with the same AC-Cookie. In this case, the PADS is just retried.

If the broadcast domain and MAC is equal but AC-Cookie is different, this PADR must be considered as a new request.

This allows to separate two different PPPoE sessions on the same VLAN from the same MAC as frequently used by some service providers.



When forwarding PPPoE packets, the TTL value is increased to '254' in the outgoing IP packets.

PPPoE Session Limit

A customer line is typically represented by one (single-tagged) or two VLAN (double-tagged) on a physical interface with a limitation to one session, which is also called the 1:1 VLAN mode.

In some cases, the customer CPE will set up multiple PPPoE sessions on a single VLAN which requires MAC limitations greater than one but less or equal to the per VLAN limitation.

Therefore RBFS supports two different session limitations in the access interface configuration (Access Interface Configuration), one per VLAN (max-subscribers-per-vlan) and an additional per client MAC address (max-subscribers-per-mac) both set to 1 per default as required for 1:1 VLAN mode.

The limitation of sessions per client MAC address must be less or equal the sessions per VLAN and the default set to one for both limits.

PPPoE N:1 Multi-VRF Subscriber Support on Shared IFP/VLAN

RBFS supports PPPoE N:1 subscribers on the same IFP and VLAN, allowing them to be distributed across multiple routing instances (VRFs). Multiple VRFs can coexist on the same IFP and VLAN, ensuring that each individual subscriber session is associated with only one VRF. This enables logically separated services over shared access infrastructure, without interference between subscribers.

MTU Profiles

Bare metal switch hardware is typically limited in the number of supported MTU values. So RBFS has introduced the concept of MTU profiles with different types like physical, ip, IPoE, or pppoe. The last one is reserved for use with PPPoE sessions and applies to IPv4 and IPv6 traffic.

```
supervisor@switch: cfg> show config forwarding-options mtu-profile
{
  "rtbrick-config:mtu-profile": [
    {
      "mtu-profile-name": "IP-MTU-1500",
      "size": 1500,
      "type": "ip",
      "action": "redirect-to-cpu"
    },
    {
      "mtu-profile-name": "IP-MTU-9202",
      "size": 9202,
      "type": "ip",
      "action": "drop"
    },
    {
      "mtu-profile-name": "__default_pppoe__",
      "size": 1492,
      "type": "pppoe",
      "action": "redirect-to-cpu"
    }
  ]
}
```



The physical access interface should be configured with an MTU

> profile large enough to serve all IPoE and PPPoE MTU profiles, including the additional overhead for PPPoE and VLAN headers. Further details about interface MTU profiles can be found in the *Interfaces Configuration Guide*.

The Q2a/Q2c platform supports up to 8 MTU profiles in total including the default PPPoE profile *default_pppoe*. The default profile cannot be deleted but overwritten to change size and action. For PPPoE type, you can create multiple profiles, but only one of the eight available MTU profiles is consumed for all configured PPPoE profiles. However, the action of all PPPoE MTU profiles must be the same.

The action could be either drop or redirect-to-cpu. The action drop silently discards all oversized packets. The action redirect-to-cpu punts oversized packets to the CPU where those could be either fragmented or dropped with ICMP response.

Fragmentation in software (cpu) must be explicitly enabled:

```
supervisor@switch: cfg> show config forwarding-options fragmentation
{
  "rtbrick-config:fragmentation": {
    "ipv4": {
      "state": "cpu"
    }
  }
}
```

MTU Profile Support for PPPoE Subscribers

The Point-to-Point Protocol (PPP) facilitates the negotiation of a Maximum Receive Unit (MRU) between endpoints, which is then applied as the Maximum Transmission Unit (MTU) on the opposite end of the PPP link. It is standard for each endpoint to independently negotiate its MRU, leading to potentially different MTU values for each direction of the PPP connection.

As an Internet Service Provider (ISP), control over the MTU/MRU sizes utilized for PPP over Ethernet (PPPoE) is not completely under your control. To address this, RBFS adopts a unique approach to managing PPPoE MTU profiles. Within RBFS, you can configure multiple PPPoE MTU profiles, however, they collectively count as a single entity against the eight MTU profile slots available on the Q2a/Q2c platform.

When a client initiates an MRU request via PPP Link Control Protocol (LCP) Configure-Request, RBFS employs this value to identify a matching MTU profile.

This process involves sequentially comparing the requested MRU against an ordered list of MTU profiles until a profile with an MTU size equal to or greater than the requested MRU is located. If an exact match is found, the corresponding profile is selected, the exact match counter is incremented, and the MRU is deemed acceptable.

If no exact match exists, the system selects the closest, yet smaller, MTU profile from the list. This selection increments the best match counter, and the MTU from this profile is proposed to the client through a PPP LCP Configure-Nak message. Should the client reject the proposed MRU after three attempts, RBFS applies the default MTU profile *default_pppoe* as fallback MTU profile. This protocol ensures that the client's requested MRU is honored, but the transmission is governed by the largest available PPPoE MTU profile, thereby maximizing client compatibility.

For example, if a client requests an MRU of 1482 bytes but only profiles for 1472 and 1492 bytes are configured, the system will offer 1472 bytes as the best match through a PPP LCP Configure-Nak. The client may accept this offer by submitting a new PPP LCP Configure-Request for 1472 bytes or persist with the initial request of 1482 bytes. After three iterations without agreement, the fallback profile is activated, accepting the client's MRU of 1482 bytes but applying the default MTU of 1492 bytes. This approach is justified as most Customer Premises Equipment (CPE) devices support TCP Maximum Segment Size (MSS) clamping based on the negotiated MRU, ensuring that at least TCP traffic adheres to the negotiated limit. Furthermore, it is not unusual for CPEs to accept packets exceeding the negotiated MRU, which is why a larger MTU profile is designated as the fallback.

The negotiated MRU and applied MTU can be verified with the following command for every single PPPoE session.

```
user@switch: op> show pppoe session 72339069014638648 detail
Subscriber-Id: 72339069014638648
    State: ESTABLISHED
    ...
    PPP LCP:
        ...
        MRU: 1492 Peer: 1492
        MTU: 1492 Profile: __default_pppoe__
    ...
```

The command show pppoe mtu-profile lists all PPPoE MTU profiles in increasing order, with two statistics about the exact and best match.

```
supervisor@switch: op> show pppoe mtu-profile
Profile                MTU      Exact Match      Best Match
PPPoE-MTU-1320         1320     0                0
PPPoE-MTU-1456         1456     0                0
PPPoE-MTU-1472         1472     0                0
__default_pppoe__      1492     0                0
```

The exact and best match counters can be used by operators to verify if the configured MTU profiles fit their environment or should be adopted.

As specified in RFC 2516, the Point-to-Point Protocol over Ethernet (PPPoE) requires a maximum negotiated MTU/MRU of 1492 bytes. However, RFC 4638 introduces the PPP-Max-Payload Tag, which extends the maximum negotiable MTU/MRU beyond 1492 bytes. This enhancement aims to reduce fragmentation within emerging broadband networks.

To configure an MTU/MRU exceeding 1492 bytes, a PPPoE client must incorporate the PPP-Max-Payload Tag within the PADI and PADR packets. Should the PPP-Max-Payload Tag specify a value greater than 1492 bytes, and if either the PPP LCP MRU or the MTU outlined in the access-profile is also configured above 1492, the tag will be replicated into the PADO and PADS packets issued by the RBFS. Echoing the PPP-Max-Payload Tag to the client signales support for MTU/MRU beyond 1492 bytes.

The value indicated by the PPP-Max-Payload Tag establishes the maximum threshold for both MTU and MRU settings.

Therefore, the highest permissible MTU/MRU is determined by the smaller of the two values, the configured PPP LCP MTU/MRU or the PPP-Max-Payload Tag's value.

At least one of the following values must be set to a value of more than 1492 bytes:

```
set access access-profile pppoe-dual protocol ppp lcp mru 1500
set access access-profile pppoe-dual protocol ppp lcp mtu 1500
```

It is also required to set an MTU profile with the desired MTU size:

```
set forwarding-options mtu-profile pppoe-1500
set forwarding-options mtu-profile pppoe-1500 size 1500
set forwarding-options mtu-profile pppoe-1500 type pppoe
set forwarding-options mtu-profile pppoe-1500 action redirect-to-cpu
```

For L2TPv2 tunneled PPPoE sessions, the MTU is enforced by the LNS. It's usual

behavior that the LNS renegotiates the MTU. So LAC may not know the actual MTU. This is the reason why RBFS does not apply an MTU profile for such sessions.

RBFS overwrites the selected MTU profile with *default_l2tp* for L2TPv2 sessions. This profile must be explicitly created, otherwise it is ignored. The action must be drop because ICMP or fragmentation is not supported for tunneled sessions.

```
supervisor@switch: cfg> show config forwarding-options mtu-profile
__default_l2tp__
{
    "rtbrick-config:mtu-profile": [
      {
        "mtu-profile-name": "__default_l2tp__",
        "size": 1492,
        "type": "pppoe",
        "action": "drop"
      }
    ]
  }
```

This configuration allows to optionally enforce an MTU on LAC if needed.

Following an example MTU profile configuariton for PPPoE supporting all MTU values between the minimum of 1280 and maximum of 1500 in steps of 8 bytes.

```
supervisor@switch: cfg> show config forwarding-options mtu-profile
{
  "rtbrick-config:mtu-profile": [
    {
      "mtu-profile-name": "__default_pppoe__",
      "size": 1492,
      "type": "pppoe",
      "action": "redirect-to-cpu"
    },
    {
      "mtu-profile-name": "PPPoE-MTU-1280",
      "size": 1280,
      "type": "pppoe",
      "action": "redirect-to-cpu"
    },
    {
      "mtu-profile-name": "PPPoE-MTU-1288",
      "size": 1288,
      "type": "pppoe",
      "action": "redirect-to-cpu"
    },
    {
      "mtu-profile-name": "PPPoE-MTU-1296",
      "size": 1296,
      "type": "pppoe",
      "action": "redirect-to-cpu"
    },
    {
```

```
      "mtu-profile-name": "PPPoE-MTU-1304",
      "size": 1304,
      "type": "pppoe",
      "action": "redirect-to-cpu"
    },
    {
      "mtu-profile-name": "PPPoE-MTU-1312",
      "size": 1312,
      "type": "pppoe",
      "action": "redirect-to-cpu"
    },
    {
      "mtu-profile-name": "PPPoE-MTU-1320",
      "size": 1320,
      "type": "pppoe",
      "action": "redirect-to-cpu"
    },
    {
      "mtu-profile-name": "PPPoE-MTU-1328",
      "size": 1328,
      "type": "pppoe",
      "action": "redirect-to-cpu"
    },
    {
      "mtu-profile-name": "PPPoE-MTU-1336",
      "size": 1336,
      "type": "pppoe",
      "action": "redirect-to-cpu"
    },
    {
      "mtu-profile-name": "PPPoE-MTU-1344",
      "size": 1344,
      "type": "pppoe",
      "action": "redirect-to-cpu"
    },
    {
      "mtu-profile-name": "PPPoE-MTU-1352",
      "size": 1352,
      "type": "pppoe",
      "action": "redirect-to-cpu"
    },
    {
      "mtu-profile-name": "PPPoE-MTU-1360",
      "size": 1360,
      "type": "pppoe",
      "action": "redirect-to-cpu"
    },
    {
      "mtu-profile-name": "PPPoE-MTU-1368",
      "size": 1368,
      "type": "pppoe",
      "action": "redirect-to-cpu"
    },
    {
      "mtu-profile-name": "PPPoE-MTU-1376",
      "size": 1376,
      "type": "pppoe",
      "action": "redirect-to-cpu"
    },
    {
      "mtu-profile-name": "PPPoE-MTU-1384",
```

```
      "size": 1384,
      "type": "pppoe",
      "action": "redirect-to-cpu"
    },
    {
      "mtu-profile-name": "PPPoE-MTU-1392",
      "size": 1392,
      "type": "pppoe",
      "action": "redirect-to-cpu"
    },
    {
      "mtu-profile-name": "PPPoE-MTU-1400",
      "size": 1400,
      "type": "pppoe",
      "action": "redirect-to-cpu"
    },
    {
      "mtu-profile-name": "PPPoE-MTU-1408",
      "size": 1408,
      "type": "pppoe",
      "action": "redirect-to-cpu"
    },
    {
      "mtu-profile-name": "PPPoE-MTU-1416",
      "size": 1416,
      "type": "pppoe",
      "action": "redirect-to-cpu"
    },
    {
      "mtu-profile-name": "PPPoE-MTU-1424",
      "size": 1424,
      "type": "pppoe",
      "action": "redirect-to-cpu"
    },
    {
      "mtu-profile-name": "PPPoE-MTU-1432",
      "size": 1432,
      "type": "pppoe",
      "action": "redirect-to-cpu"
    },
    {
      "mtu-profile-name": "PPPoE-MTU-1440",
      "size": 1440,
      "type": "pppoe",
      "action": "redirect-to-cpu"
    },
    {
      "mtu-profile-name": "PPPoE-MTU-1448",
      "size": 1448,
      "type": "pppoe",
      "action": "redirect-to-cpu"
    },
    {
      "mtu-profile-name": "PPPoE-MTU-1456",
      "size": 1456,
      "type": "pppoe",
      "action": "redirect-to-cpu"
    },
    {
      "mtu-profile-name": "PPPoE-MTU-1464",
      "size": 1464,
```

```
      "type": "pppoe",
      "action": "redirect-to-cpu"
    },
    {
      "mtu-profile-name": "PPPoE-MTU-1472",
      "size": 1472,
      "type": "pppoe",
      "action": "redirect-to-cpu"
    },
    {
      "mtu-profile-name": "PPPoE-MTU-1480",
      "size": 1480,
      "type": "pppoe",
      "action": "redirect-to-cpu"
    },
    {
      "mtu-profile-name": "PPPoE-MTU-1488",
      "size": 1488,
      "type": "pppoe",
      "action": "redirect-to-cpu"
    },
    {
      "mtu-profile-name": "PPPoE-MTU-1490",
      "size": 1490,
      "type": "pppoe",
      "action": "redirect-to-cpu"
    },
    {
      "mtu-profile-name": "PPPoE-MTU-1500",
      "size": 1500,
      "type": "pppoe",
      "action": "redirect-to-cpu"
    }
  ]
}
```

MTU Profile Support for IPoE Subscribers

Unlike the PPPoE protocol, which can negotiate MTU dynamically, IPoE relies on a fixed MTU setting. The MTU value is predefined and remains constant for all IPoE subscribers using the configured access interface.

For IPoE subscribers, MTU is statically configured and is applied at the access interface level.

Configuration commands for the MTU profile for IPoE subscribers.

```
set access access-profile ipoe
set access access-profile ipoe instance default
set access access-profile ipoe protocol dhcp enable true
set access access-profile ipoe protocol dhcp lease-time 3600
set access access-profile ipoe protocol dhcpv6 enable true
set access access-profile ipoe protocol dhcpv6 lifetime 3600
set access access-profile ipoe protocol ipoe ip-mtu-profile ipoe_mtu_1500
```

It is also required to set an MTU profile with the desired MTU size:

```
set forwarding-options mtu-profile ipoe_mtu_1500
set forwarding-options mtu-profile ipoe_mtu_1500 size 1500
set forwarding-options mtu-profile ipoe_mtu_1500 type ip
set forwarding-options mtu-profile ipoe_mtu_1500 action drop
```

Following is an example of access profile IPoE:

```
supervisor@rtbrick.net: cfg> show config access access-profile ipoe
{
  "rtbrick-config:access-profile": [
    {
      "profile-name": "ipoe",
      "instance": "default",
      "protocol": {
        "dhcp": {
          "enable": "true",
          "lease-time": 3600
        },
        "dhcpv6": {
          "enable": "true",
          "lifetime": 3600
        },
        "ipoe": {
          "ip-mtu-profile": "ipoe_mtu_1500"
        }
      },
      "address-family": {
        "ipv4": {
          "enable": "true",
          "pool-name": "poolv4"
        },
        "ipv6": {
          "enable": "true",
          "pool-name": "poolv6",
          "prefix-delegation-pool-name": "poolv6pd"
        }
      }
    }
  ]
}
```

Following an example MTU profile configuariton for IPoE:

```
supervisor@DT-STD-23-2401>bm13-tst.fsn.rtbrick.net: cfg> show config forwarding-
options mtu-profile
{
  "rtbrick-config:mtu-profile": [
    {
      "mtu-profile-name": "ipoe_mtu_1500",
      "size": 1500,
      "type": "ip",
      "action": "drop"
    }
```

```
  ]
}
```

PPPoE VLAN Profiles

This chapter describes the VLAN profile feature. If enabled for the access interface, then incoming sessions (e.g. PPPoE PADI/PADR) are not honored unless matching vlan-profile is found.

The VLAN profiles must be added to the table global.vlan.profile owned by PPPoE daemon. All entries in this table are ephemeral and therefore lost after reboot or PPPoE daemon restart.

Example:

```
{
    "table": {
        "table_name": "global.vlan.profile"
    },
    "objects": [
        {
            "attribute": {
                "ifp_name": "ifp-0/1/2",
                "outer_vlan_min": 128,
                "outer_vlan_max": 128,
                "inner_vlan_min": 1,
                "inner_vlan_max": 4095,
                "access_profile_name": "access-profile-vlan"
            }
        }
    ]
}
```

PPPoE Dual-Stack IPv4/IPv6 with DHCPv6

The whole IPv6 control plane of a PPPoE session like ICMPv6 router-solicitation (RS), ICMPv6 router-advertisement (RA) and DHCPv6 is handled in the PPPoE daemon (pppoed).

The PPPoE daemon handles received router solicitations by responding with router advertisements and is sending frequent router advertisements based on configured intervals.

The other-config flag in the router-advertisement is automatically set if DHCPv6 is enabled for this particular subscriber. This flag signals that there is more information available via DHCPv6.

DHCPv6 over PPPoE is different to DHCPv6 over Ethernet because of the special characteristics of point-to-point protocols. DHCPv6 over PPPoE is supporting delegated IPv6 prefixes (IA_PD) and DNS options only. Unsupported IA options (IA_NA and IA_TA) or options that can be served will be rejected with status code options as defined per RFC.

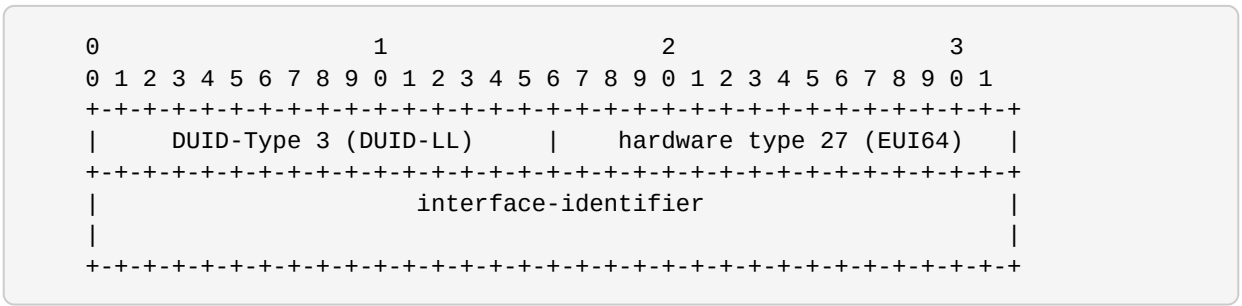
The delegated IPv6 prefix served by DHCPv6 will be assigned to the subscriber via RADIUS or local pool regardless of the protocols negotiated with the client. DHCPv6 was primarily designed for use in Ethernet networks. The fact that Ethernet is connectionless requires that DHCPv6 servers must manage releases for the clients and free them automatically if a lease expires. Such extensive release management is not needed for connection-oriented protocols like PPPoE where addresses are assigned to the PPPoE session. This fact allows to implementing DHCPv6 nearly stateless on the server side by just tracking if an assigned prefix is assigned or released. This is tracked in the attribute ipv6pd_negotiated of the PPPoED/SubscriberD (global.ppp.1.subscriber.result) result object and copied to the actual subscriber object (local.access.subscriber). As this use case is covered by PPPoE, there is no lease expiry implemented.

The delegated-prefix is added to the subscriber-ifl only if negotiated and removed if not negotiated. The presence of delegated prefix in the subscriber-ifl is used by IFMD to add or remove the forwarding entry.

If DHCPv6 is enabled but no delegated prefix provided, only DNS is served in response if available.

PPPoE DHCPv6 Server DUID

The DHCPv6 server identifier DUID is generated based on IP6CP negotiated interface-identifier as shown below:



Support for Preventing Simultaneous PPPoE and IPoE Subscriber Sessions on the Same VLAN

RBFS can prevent simultaneous IPoE and PPPoE subscriber sessions on the same VLAN. While the system allows either access type (IPoE or PPPoE) to be dynamically accepted on a shared VLAN, it does not support both IPoE and PPPoE subscriber sessions active at the same time. The subscriber daemon can detect existing subscriber access type on an IFP VLAN and reject any new subscriber request that conflicts with the currently active access type.

Layer Two Tunneling Protocol (L2TPv2)

This chapter describes the RtBrick Layer Two Tunneling Protocol (L2TPv2) implementation. This document describes also the corresponding configuration and operations commands for PPPoE access services with PPP tunneling using the Layer Two Tunneling Protocol version 2 (L2TPv2) on RtBRick FullStack (RBFS).

Typically, a user obtains a Layer 2 (L2) point-to-point connection to a Broadband Network Gateway (BNG) using the PPPoE protocol as described in RFC 2516 and runs PPP over that connection. In the most common case, the L2 termination point and PPP session endpoint reside on the same physical device. Tunneling protocols, such as L2TPv2 provide a dynamic mechanism for extending PPP by allowing the L2 and PPP endpoints reside on different devices that are interconnected by an IP network. This separation allows the actual processing of PPP packets to be divorced from the termination of the L2 circuit. The L2TP access concentrator (LAC) physically terminates the L2 connection and tunnels the PPP packets across an IP network to the L2TP network server (LNS). The LNS then terminates the logical PPP connection.



RFC and draft compliance are partial except as specified.

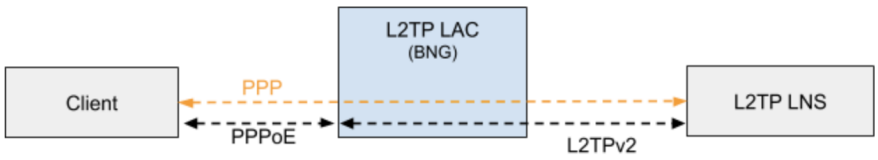


Figure 61. L2TP PPPoE

To establish a PPPoE session via L2TP, the tunnel-type must be configured as L2TP. This configuration can be achieved either for local users or by utilizing the corresponding tunnel-type attribute through RADIUS.

```
# Local User
cfg> set access user-profile local@l2tp tunnel-type L2TP

# FreeRADIUS
"radius@l2tp" Cleartext-Password := "test"
    Service-Type = Framed-User,
    Framed-Protocol = PPP,
    Tunnel-Type:0 = L2TP
```

Defining an L2TP configuration profile is essential, which can be referenced through an access-profile or by employing the appropriate RADIUS VSA. The actual tunnels may either be defined locally via an L2TP pool configuration or set up dynamically through RADIUS.



Currently, RBFS supports L2TP subscriber sessions with EtherType 0x8100 (802.1Q) only; it does not support EtherType 0x88a8 (802.1ad).

L2TP LAC

The L2TP Access Concentrator (LAC) is a node that acts as one side of an L2TP tunnel endpoint, and is a peer to the L2TP Network Server L2TP LNS. The LAC sits between a LNS and a remote system, and forwards packets to and from each.

L2TP LNS

The L2TP Network Server (LNS) is a node that acts as one side of an L2TP tunnel endpoint and is a peer to the L2TP Access Concentrator L2TP LAC. The LNS is the logical termination point of a PPP session that is being tunneled from the remote system by the LAC.



The LNS role is currently not supported!

L2TP Tunnel Selection

Each new session creates a session request object (local.l2tp.session.request) to track the tunnel selection progress, the currently selected ones, and which are already tried. This object is automatically deleted if the session setup is successful.

All tunnels in state DEAD are skipped in the tunnel selection but considered at the end if no other tunnels are available. Tunnels with a session limit reached are not considered for further sessions. To select a tunnel, the L2TP daemon first generates list of preferred tunnels based on tunnel preference, where the lowest

value has the highest priority. The configured L2TP tunnel selection algorithm decides how to select a tunnel out of the remaining tunnels with the same preference. The RANDOM algorithm selects the tunnel randomly whereas BALANCED selects the least filled tunnel based on the number of sessions.

Following the L2TP tunnel pool order/priority in case, there are multiple pools available for a single subscriber:

1. RADIUS defined tunnel (RFC2866)
2. RADIUS VSA (RtBrick-L2TP-Pool) or local user profile
3. L2TP configuration profile

L2TP Control Channel

The control channel is responsible for the orderly passing of control messages between the tunnel endpoints and acts as a transport layer for reliable delivery of control messages and tunnel keep alive services for the tunnel.

Each L2TP tunnel is split into the actual tunnel object with all the information exchanged during tunnel establishment plus the FSM state and a separate control channel with the sequence numbers, window size, and thresholds changed with every sent and received packet.

RBFS sent a ZLB ACK only if there are no further messages waiting in queue for that peer, as well as to acknowledge multiple packets at once.

The HELLO keep-alive messages are also part of the control channel and only send if there is no other message sent if the queue is empty and no other message send during the hello interval.

Support N:1 VLAN (Shared VLAN) Model for L2TP Subscribers

RBFS supports for L2TP subscribers using the N:1 VLAN model, also known as the shared VLAN model, on the following platforms:

- Edgecore AGR400 (AS7946-30XB)
- UfiSpace S9600-102XC
- UfiSpace S9600-72XC platforms.

This feature is enabled, by default.

L2TP Access Line Information (RFC5515)

Connect-Speed-Update-Notification (CSUN)

The Connect-Speed-Update-Notification (CSUN) is an L2TP control message sent by the LAC to the LNS to provide transmit and receive connection speed updates for one or more sessions.



This implementation will send one CSUN request per session!

CSUN requests are disabled per default and can be enabled in the L2TP profile L2TP Profile Configuration.

CSUN messages are defined in RFC5515, which is not widely supported. Therefore those messages are marked as not mandatory in RBFS to allow interwork with LNS servers not supporting RFC5515.

RFC2661:

```
The Mandatory (M) bit within the Message Type AVP has special
meaning. Rather than an indication of whether the AVP itself
should be ignored if not recognized, it is an indication as to
whether the control message itself should be ignored. Thus, if the
M-bit is set within the Message Type AVP and the Message Type is
unknown to the implementation, the tunnel MUST be cleared.  If the
M-bit is not set, then the implementation may ignore an unknown
message type.
```



RFC and draft compliance are partial except as specified.

Connect-Speed-Update-Request (CSURQ)

The Connect-Speed-Update-Request (CSURQ) is an L2TP control message sent by the LNS to the LAC to request the current transmission and receive connection speed for one or more sessions.



Sending or responding to CSURQ requests is currently not supported!

Access Line Information L2TP Attribute Value Pair Extensions

The corresponding access line information for a subscriber is included in the ICRQ message as defined in RFC5515.

Connect Speed Values

The default value for TX and RX Connect Speed is set to 1000000000 (1G) which is replaced by the actual data rate upstream/downstream of the corresponding access line information object or directly set using the RADIUS attributes RtBrick-L2TP-Tx-Connect-Speed (42) and RtBrick-L2TP-Rx-Connect-Speed (43).

IPoE

IP-over-Ethernet (IPoE) is a popular alternative to PPPoE based access using DHCP for IPv4 and DHCPv6 for IPv6 where both protocols are handled in the IPoE daemon (ipoed).

IPoE subscribers are identified by Agent-Remote-Id, Agent-Circuit-Id, interface, VLAN or MAC address.

The dynamic creation of IPoE subscribers is triggered by the first DHCPv4 discovery or DHCPv6 solicit request received. Any response is postponed until the subscriber is successfully authenticated using known authentication methods like none, local or RADIUS. For DHCP mode server all addresses are assigned during authentication to the subscriber and used by DHCPv4 and DHCPv6 to handle client requests. For the DHCP relay mode, all IP addresses are allocated by an external DHCP server. Forwarding of requests to the configured servers is also postponed until the subscriber is authenticated.

IPoE subscribers will be terminated automatically if all protocol bindings have been expired or failed.

IPoE VLAN Support

RBFS supports both VLAN models, 1:1 and N:1 for IPoE subscribers.

1:1 VLAN (VLAN-per-subscriber) Model

In the 1:1 VLAN model, there is a unique dedicated customer VLAN for a subscriber, that is one VLAN per subscriber. This model establishes a unique path between each subscriber interface and the router for data transmission by providing traffic separation for every subscriber.

1:1 model operations are relatively simple as it provides one-to-one mapping of specific VLANs to specific subscribers. New services can be added easily without

affecting other subscribers and services with this model.

The following diagram shows a dedicated customer VLAN for a subscriber, that is, one VLAN per subscriber.

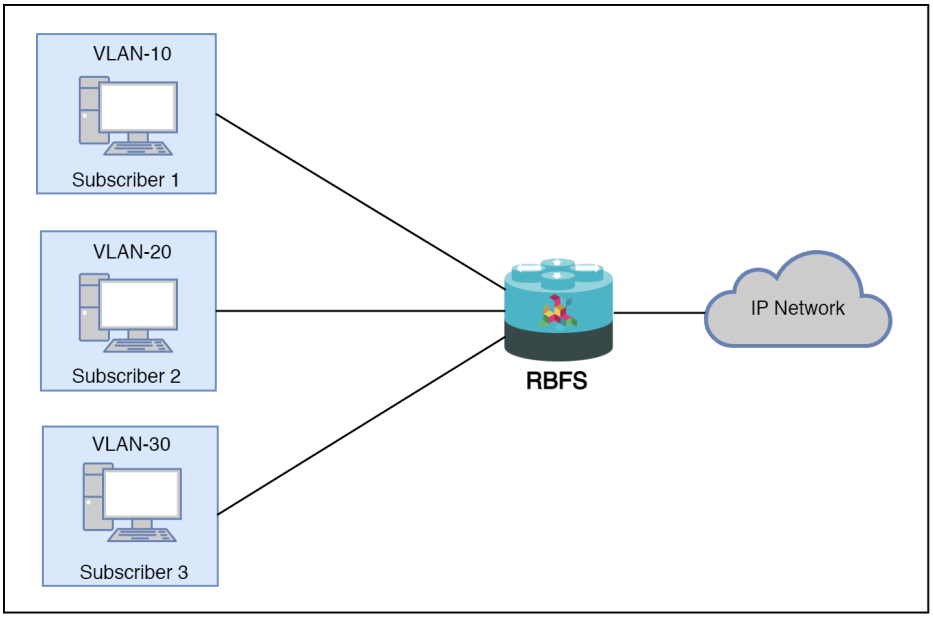


Figure 62. 1:1 VLAN (VLAN-per-subscriber)

N:1 VLAN (Shared VLAN) Model

The shared VLAN model provides many-to-one (N:1) subscriber-to-service connectivity. This model provides a single VLAN to many subscribers. Unlike in the 1:1 model, in which the VLAN is dedicated to a customer, N:1 provides a shared VLAN to many subscribers, and this VLAN carries all types of service (i.e., data, voice, video, etc.). One disadvantage of shared VLAN is the lack of logical isolation between user sessions at the VLAN level.

The following diagram shows a single VLAN that is connected to many subscribers.

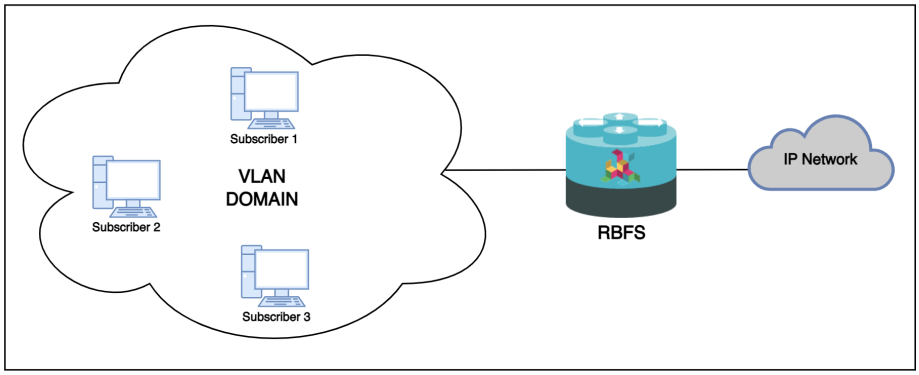


Figure 63. N:1 VLAN (Shared VLAN-per-service)

Limitations for IPoE N:1 VLAN

Access services such as http-redirect and subscriber-acl are currently not supported for IPoE N:1 subscribers.

IPoE Session Limit

A customer line is typically represented by one (single-tagged) or two VLAN (double-tagged) on a physical interface with a limitation to one subscriber, which is also called the 1:1 VLAN mode.

IPoE subscribers are implicitly limited to max one per MAC address, as client MAC address is used as part of the key to identify subscribers.

IPoE Username

For each IPoE subscriber, a username is generated automatically using the client's MAC address followed by @ipoe.

Example: fe:08:e8:ea:1d:32@ipoe

IPoE DHCPv6 Server DUID

The generated DHCPv6 server identifier DUID is from type 3 (DUID-LL) with hardware type 27 (EUI64) and IFP MAC address to derive the EUI64 interface identifier.

```
0                   1                   2                   3
0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|     DUID-Type 3 (DUID-LL)     |    hardware type 27 (EUI64)   |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                      interface-identifier                     |
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

IPoE DHCP Relay

When IPoE is configured on relay mode, the system relies on an external DHCP server for IP address allocation and client configuration functions. The DHCP server contains a pool of IP addresses, and from that pool, it allocates addresses to subscribers. RBFS acts as a DHCP relay during its interaction with the DHCP server. The feature allows multiple RBFS instances to use a single centralized DHCP server

for their IP allocation.

For information on how to configure IPoE in relay mode, see the sections DHCPv4 and DHCPv6.

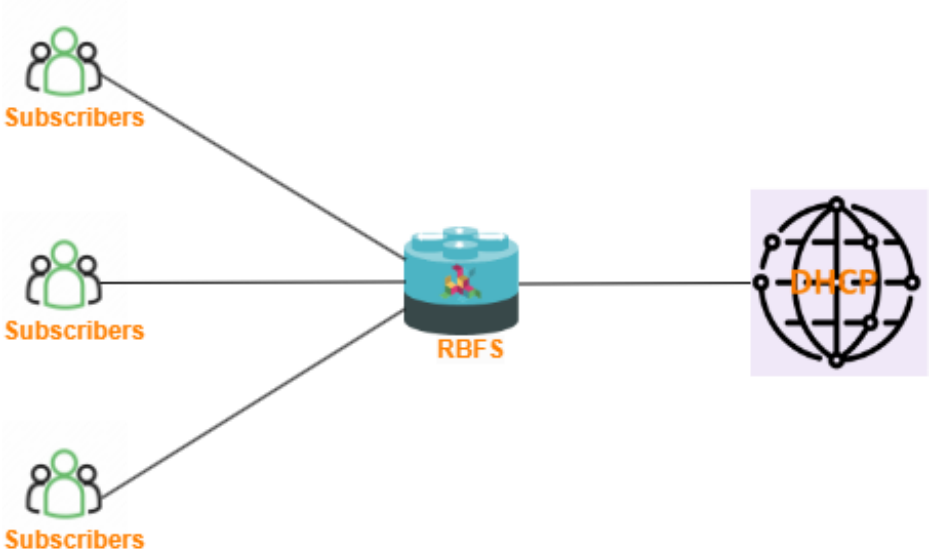


Figure 64. IPoE DHCP Relay

For DHCPv4 relay, the gateway IFL's primary address is used as GIADDR. This address may also serve as the default gateway for clients, although it is not necessarily so. Since we assume proxy ARP is enabled for all addresses, customers can assign addresses in blocks and choose a gateway from within that block. This setup works even if the chosen IP address is not configured on our BNG, as proxy ARP resolves it.

For DHCPv6, only the primary global address from the gateway IFL is used as the link address towards the server. If this is not set, the link-local address is used, which is always employed as the gateway for the client by ICMPv6 RA.

For DHCPv6, RBFS constructs the Interface-Id as shown below.

```
<ifp>#<outer-vlan>#<innter-vlan>#<subscriber-id>
```

It is important to note that RBFS sets the Interface-Id only on its own relay header, leaving any nested headers (such as those added by LDRA at the OLT) unchanged. This allows DHCPv6 servers to match individually on those nested headers.

IPoE DHCPv4 Options Supported

The following table provides an overview of all options supported by RBFS.

In relay mode, unsupported options are still forwarded along with the supported ones.

DHCP Options

Options	Sub-options	Description	Comment
0	-	Pad	-
1	-	Subnet Mask	-
3	-	Router	-
6	-	Domain Server	-
50	-	Address Request	-
51	-	Address Time	-
53	-	DHCP message type	-
54	-	DHCP Server ID	-
55	-	Parameter list	-
56	-	DHCP message	-
61	-	Client ID	-
82	-	Relay agent information	-
82	1	Agent circuit ID	-
82	2	Agent Remote ID	-
82	9	Vendor Specific	-
255	-	End	-

The following table provides vendor-specific relay options (DHCP Option 82, sub-option 9). Access line attributes within Broadband Forum (3561) options are recognized by RBFS as access line attributes and are also forwarded to RADIUS.

DHCP Vendor Options

Vendor Options	Sub-options	Description	Comment
3561	129	Actual Data Rate Upstream	-
3561	130	Actual Data Rate Downstream	-
3561	131	Minimum Data Rate Upstream	-
3561	132	Minimum Data Rate Downstream	-
3561	133	Attainable DataRate Upstream	-
3561	134	Attainable DataRate Downstream	-
3561	135	Maximum Data Rate Upstream	-
3561	136	Maximum Data Rate Downstream	-
3561	137	Minimum Data Rate Upstream in low power state	-
3561	138	Minimum Data Rate Downstream in low power state	-
3561	139	Maximum Interleaving Delay Upstream	-
3561	140	Actual Interleaving Delay Upstream	-
3561	141	Maximum Interleaving Delay Downstream	-
3561	142	Actual Interleaving Delay Downstream	-
3561	144	Data Link Encapsulation	-
3561	145	DSL Type	-
3561	146	PON-Access-Type	Backward compatibility with LIHAWI draft version 00.
3561	147	ONT/ONU-Average-Data-Rate-Downstream	Backward compatibility with LIHAWI draft version 00.

Vendor Options	Sub-options	Description	Comment
3561	148	ONT/ONU-Peak-Data-Rate-Downstream	Backward compatibility with LIHAWI draft version 00.
3561	149	ONT/ONU-Maximum-Data-Rate-Upstream	Backward compatibility with LIHAWI draft version 00.
3561	150	ONT/ONU-Assured-Data-Rate-Upstream	Backward compatibility with LIHAWI draft version 00.
3561	151	PON-Access-Type / PON-Tree-Maximum-Data-Rate-Upstream	If value is > 999, RBFS interprets as PON-Tree-Maximum-Data-Rate-Upstream as defined by LIHAWI version 00, otherwise as PON-Access-Type.
3561	152	PON-Tree-Maximum-Data-Rate-Downstream	Backward compatibility with LIHAWI draft version 00.
3561	155	Expected Throughput (ETR) Upstream	-
3561	156	Expected Throughput (ETR) Downstream	-
3561	157	Attainable Expected Throughput (ATTETR) Upstream	-
3561	158	Attainable Expected Throughput (ATTETR) Downstream	-
3561	159	Gamma Data Rate (GDR) Upstream	-
3561	160	Gamma Data Rate (GDR) Downstream	-
3561	161	Attainable Gamma Data Rate (ATTGDR) Upstream	-

Vendor Options	Sub-options	Description	Comment
3561	162	Attainable Gamma Data Rate (ATTGDR) Downstream	-
3561	176	ONT/ONU-Average-Data-Rate-Downstream	-
3561	177	ONT/ONU-Peak-Data-Rate-Downstream	-
3561	178	ONT/ONU-Maximum-Data-Rate-Upstream	-
3561	179	ONT/ONU-Assured-Data-Rate-Upstream	-
3561	180	PON-Tree-Maximum-Data-Rate-Upstream	-
3561	181	PON-Tree-Maximum-Data-Rate-Downstream	-

IPoE DHCPv6 Options Supported

The following table provides the list of all the IPoE DHCPv6 options supported by RBFS. In relay mode, unsupported options are still forwarded along with the supported ones.

DHCP Options

Options	Sub-options	Description	Comment
1	-	OPTION_CLIENTID	-
2	-	OPTION_SERVERID	-
3	-	OPTION_IA_NA	-
6	-	OPTION_ORO	-
8	-	OPTION_ELAPSED_TIME	-
9	-	OPTION_RELAY_MSG	-
13	-	OPTION_STATUS_CODE	-

Options	Sub-options	Description	Comment
14	-	OPTION_RAPID_COMMIT	-
17	-	OPTION_VENDOR_OPTS	-
18	-	OPTION_INTERFACE_ID	-
23	-	OPTION_DNS_SERVERS	-
25	-	OPTION_IA_PD	-
26	1	OPTION_IAPREFIX	-
37	2	OPTION_REMOTE_ID	-

The list below outlines vendor-specific options (DHCP Option 17). Access line attributes within Broadband Forum (3561) options are recognized by RBFS as access line attributes and are also forwarded to RADIUS.

DHCPv6 Vendor Options

Vendor Options	Sub-options	Description	Comment
3561	129	Actual Data Rate Upstream	-
3561	130	Actual Data Rate Downstream	-
3561	131	Minimum Data Rate Upstream	-
3561	132	Minimum Data Rate Downstream	-
3561	133	Attainable DataRate Upstream	-
3561	134	Attainable DataRate Downstream	-
3561	135	Maximum Data Rate Upstream	-
3561	136	Maximum Data Rate Downstream	-
3561	137	Minimum Data Rate Upstream in low power state	-
3561	138	Minimum Data Rate Downstream in low power state	-
3561	139	Maximum Interleaving Delay Upstream	-

Vendor Options	Sub-options	Description	Comment
3561	140	Actual Interleaving Delay Upstream	-
3561	141	Maximum Interleaving Delay Downstream	-
3561	142	Actual Interleaving Delay Downstream	-
3561	144	Data Link Encapsulation	-
3561	145	DSL Type	-
3561	146	PON-Access-Type	Backward compatibility with LIHAWI draft version 00.
3561	147	ONT/ONU-Average-Data-Rate-Downstream	Backward compatibility with LIHAWI draft version 00.
3561	148	ONT/ONU-Peak-Data-Rate-Downstream	Backward compatibility with LIHAWI draft version 00.
3561	149	ONT/ONU-Maximum-Data-Rate-Upstream	Backward compatibility with LIHAWI draft version 00.
3561	150	ONT/ONU-Assured-Data-Rate-Upstream	Backward compatibility with LIHAWI draft version 00.
3561	151	PON-Access-Type / PON-Tree-Maximum-Data-Rate-Upstream	If value is > 999, RBFS interprets as PON-Tree-Maximum-Data-Rate-Upstream as defined by LIHAWI version 00, otherwise as PON-Access-Type.
3561	152	PON-Tree-Maximum-Data-Rate-Downstream	Backward compatibility with LIHAWI draft version 00.

Vendor Options	Sub-options	Description	Comment
3561	155	Expected Throughput (ETR) Upstream	-
3561	156	Expected Throughput (ETR) Downstream	-
3561	157	Attainable Expected Throughput (ATTETR) Upstream	-
3561	158	Attainable Expected Throughput (ATTETR) Downstream	-
3561	159	Gamma Data Rate (GDR) Upstream	-
3561	160	Gamma Data Rate (GDR) Downstream	-
3561	161	Attainable Gamma Data Rate (ATTGDR) Upstream	-
3561	162	Attainable Gamma Data Rate (ATTGDR) Downstream	-
3561	176	ONT/ONU-Average-Data-Rate-Downstream	-
3561	177	ONT/ONU-Peak-Data-Rate-Downstream	-
3561	178	ONT/ONU-Maximum-Data-Rate-Upstream	-
3561	179	ONT/ONU-Assured-Data-Rate-Upstream	-
3561	180	PON-Tree-Maximum-Data-Rate-Upstream	-
3561	181	PON-Tree-Maximum-Data-Rate-Downstream	-

Supported Platforms

Not all features are necessarily supported on each hardware platform. Refer to the

Platform Guide for the features and the sub-features that are or are not supported by each platform.

5.1.2. Subscriber Management Configuration Overview

RBFS Subscriber Management configuration involves setting up various profiles and parameters that control how subscribers interact with network services. This includes authentication, service access, protocol handling, and other functions organized under a structured configuration hierarchy. The profiles determine how subscribers authenticate, access network services, and use various protocols. The configuration starts with mandatory settings such as interface, access, and AAA profiles, followed by optional configurations for more features such as RADIUS, L2TP, and service profiles. Each profile plays a crucial role in ensuring efficient and secure subscriber management.

Configuration Hierarchy

The configuration of physical interfaces (IFP) and their associated VLANs is managed through a set of profiles that define parameters for various functions. These include authentication settings with AAA, service management for protocols such as IGMP and MLD, and access protocols such as PPPoE.

The following image illustrates how the subscriber management configuration and profile system are organized.

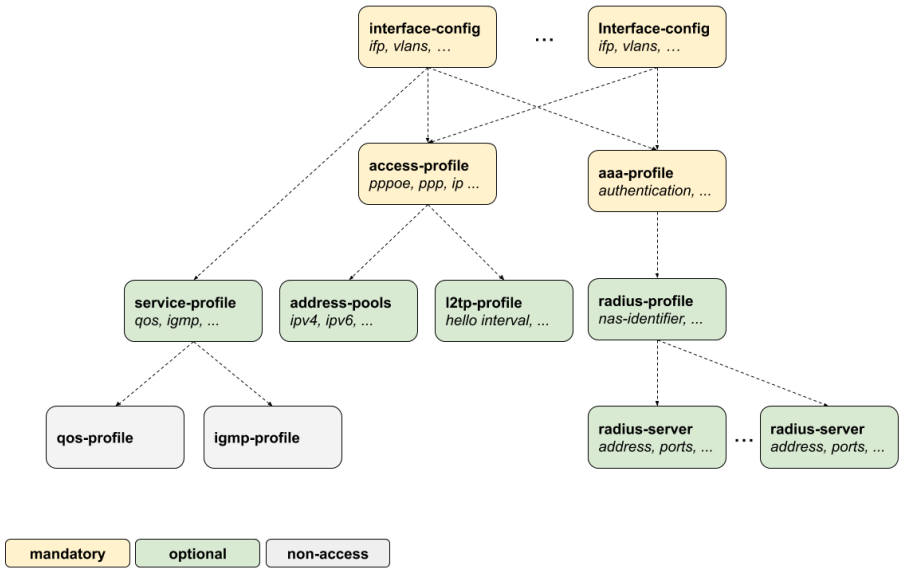


Figure 65. Configuration and Profiles

All subscriber management configurations and profiles are managed under the

top-level hierarchy access. This hierarchy acts as the central point for defining and managing various access protocols, subscriber management profiles, and authentication settings that are crucial for network operations.

The following is the high-level command syntax and the table provides command options and descriptions available for Subscriber Management configurations.

Syntax:

set access aaa-profile <profile-name> <option> **set access access-profile** <profile-name> <option> **set access chassis-id** [0 - 15] **set access dhcp-relay** <interface> <option> **set access dhcpv6-server** <server-name> <option> **set access dhcpv6-server** <server-name> **set access interface** <option> **set access l2tp-pool** <pool-name> <client-name> <server-name> <option> **set access l2tp-profile** <profile-name> <option> **set access pool** <pool-name> <option> **set access radius-profile** <profile-name> <option> **set access radius-server** <server-name> <option> **set access service-profile** <profile-name> <option> **set access terminate-history-timeout** [0 - 720] **set access user-profile** <user-name> <option>

Attribute	Description
aaa-profile	Defines global AAA profiles used for subscriber authentication, authorization, and accounting.
access-profile	Specifies global access profiles that control subscriber session behavior and policies.
chassis-id	Configures a unique chassis identifier for the node, used in subscriber session and redundancy handling. Range: 0 - 15.
dhcp-relay	Configures global DHCP relay settings to forward DHCP requests between clients and servers.
dhcp-server	Defines global DHCPv4 server configurations for dynamic IP address assignment to subscribers.
dhcpv6-server	Defines global DHCPv6 server configurations for IPv6 address and prefix assignment.
interface	Configures global access interface settings for handling subscriber traffic.

Attribute	Description
l2tp-pool	Defines global L2TPv2 tunnel endpoint pools used for subscriber session termination.
l2tp-profile	Specifies global L2TPv2 profiles that control tunnel parameters and behavior.
pool	Configures global IP address pools used for assigning addresses to subscribers.
radius-profile	Defines global RADIUS profiles for AAA communication parameters and behavior.
radius-server	Configures RADIUS server details used for subscriber authentication and accounting.
service-profile	Defines service profiles that apply policies and services to subscriber sessions.
terminate-history-timeout	Specifies the duration to retain terminated subscriber session history. Range: 0 - 720 hours.
user-profile	Defines user-specific profiles that control subscriber attributes and service parameters.

The following options can be configured directly at the global access level, rather than within subsections.

Attribute	Description
chassis-id	This option must be set to a unique value for each redundancy cluster and is only needed for stateful redundancy. Default: 0.
terminate-history-timeout	Change the retention period (in hours) for storing the termination history of subscribers after they have been disconnected. Default: 24.

The following sections provides you the steps for each configuration. The process begins with setting up the access interface configuration, which is the first step. This is then followed by other important access profile and AAA profile configurations, which are crucial for managing subscriber access.

- Access Interface Configuration
- Access Profile Configuration

- AAA Profile Configuration

The second part covers the optional configurations:

- RADIUS Profile Configuration
- RADIUS Server Configuration
- Service Profile Configuration
- L2TP Profile Configuration
- Address Pool Configuration

The user-profile and l2tp-pool are the only components not referenced by name. The key here is the user or pool name.

- User Profile Configuration
- L2TP Tunnel Pool Configuration

Access Interface Configuration

While there is no single specific way to configure subscriber management, it is ideal to start with mandatory configurations and then move on to optional ones. The access interface configuration is the anchor point for almost all further access configurations. The interface configuration defines the access type and access profile. For more information, see sections Access Profile Configuration, AAA profile AAA Profile Configuration.



Multiple interface configurations per IFP with disjoint VLAN ranges are supported.

The following image illustrates the access interface configurations and how they are associated with the entire subscriber management.

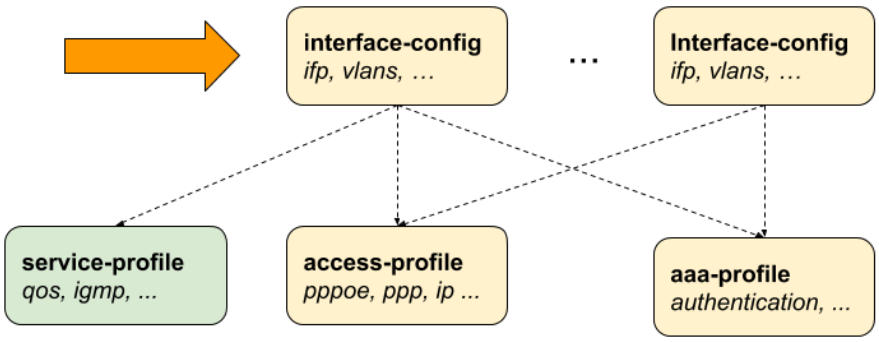


Figure 66. Access Interface Configuration

You can configure multiple interfaces for access and subscriber management, and each interface can reference the same profiles. This allows for efficient and scalable network management.

To configure the access interface, you must complete the following tasks.

1. Configure the physical interface name (IFP or LAG) and VLAN range
2. Configure the mandatory access type (PPPoE or IPoE)
3. Configure the mandatory access profile
4. Configure the mandatory AAA profile
5. Configure optional attributes such as service profile or session limit

Configuring Access Interfaces

This section describes how to configure access interfaces for subscriber management on the device. Access interfaces define how subscriber traffic is received, classified, and processed based on VLAN tagging and access type. Proper configuration ensures correct subscriber session establishment and policy application. It also enables integration with AAA, DHCP, and service profiles. Access interfaces can be configured without VLAN tags (untagged VLAN) and with one VLAN tag (single-tagged) or with two VLAN tags (double-tagged).

Syntax:

```
set access interface <option>
```

The following table provides the command options/attributes and descriptions.

Attribute	Description
-	Without any option, it configures an access interface.
access-type	Defines the access protocol used for this interface. This is a mandatory attribute. Values: PPPoE or IPoE.
access-profile-name	Specifies the name of the access profile (mandatory). For more information, see Access Profile Configuration.
aaa-profile-name	Specifies the name of the AAA profile (mandatory). For more information, see AAA Profile Configuration.
service-profile-name	This option allows assigning an optional service profile which can be dynamically overwritten via RADIUS. For more information, see Service Profile Configuration .
max-subscribers-per-vlan	This option defines the maximum number of subscribers per IFP and VLAN. A value of '1' will implicitly set the VLAN mode to 1:1 VLAN mode, where any value greater than 1 indicates N:1 VLAN mode. Default: 1 Range: 1 - 65535.
max-subscribers-per-mac	Maximum number of subscribers per IFP, VLAN, and MAC address. This option must be less or equal specified for the 'max-subscribers-per-vlan' attribute. This option does not affect IPoE subscribers, as they are inherently limited to a maximum of one per MAC address. Default: 1 Range: 1 - 65535.
outer-vlan-encapsulation	Limits the outer VLAN encapsulation to 802.1ad (TPID 0x88a8) or 802.1q (TPID 0x8100). By default, RBFS uses an auto-sensing mechanism that determines the correct TPID based on the first subscriber-initiated packet, such as PPPoE Discovery (PADI, PADR), DHCP discovery, or DHCPv6 solicit. Default: Auto-sensing. Values: 802.1ad or 802.1q.
vlan-profile-enable	If enabled, incoming PPPoE sessions (PPPoE PADI/PADR) are not honored unless matching vlan-profile is found in the table global.vlan.profile of the PPPoE daemon. For more information about VLAN profiles, see PPPoE VLAN Profiles. Default: False.
gateway-ifl	This options selects the IPoE gateway IFL (unnumbered source IFL) which is typically a loopback interface used as a gateway for IPoE subscribers.

Attribute	Description
pppoe-pado-delay	Specifies the PPPoE PADO delay, in seconds. This setting allows you to specify a wait time in seconds after receiving a PPPoE Active Discovery Initiation (PADI) control packet from a PPPoE client before sending a PPPoE Active Discovery Offer (PADO) packet to indicate that it can serve the client request. Default: Disabled. Range: 1 - 255. The PPPoE PADO delay is used for stateless high availability.
dhcp-min-elapsed-time	Defines the minimum elapsed time, in seconds, for DHCPv4/DHCPv6 transactions. This setting ensures that a DHCP request must meet the specified minimum duration before it is processed. Default: Disabled. Range: 1 - 600. The DHCPv4/v6 minimum elapsed time is used for stateless high availability.
redundancy-session-id	Specifies the redundancy session ID required for stateful high availability. Default: Disabled. Range: 1 - 65535.

API To access the RESTCONF API that corresponds to this CLI, click here.

Configuring Untagged Interfaces

This section explains how to configure interfaces that handle untagged subscriber traffic. Untagged interfaces are typically used in deployments where VLAN tagging is not required or is handled upstream. The configuration allows you to associate access profiles, AAA profiles, and subscriber policies directly with the physical interface. It is suitable for simple access deployments with minimal VLAN complexity.

Syntax:

set access interface untagged <interface-name> **aaa-profile-name** <aaa-profile-name>
set access interface untagged <interface-name> **access-profile-name** <access-profile-name>
set access interface untagged <interface-name> **access-type** [**PPPoE** |

IPoE]
set access interface untagged <interface-name> **dhcp-min-elapsed-time** [1 - 600]
set access interface untagged <interface-name> **gateway-ifl** <gateway-ifl>
set access interface untagged <interface-name> **max-subscribers-per-mac** [1 - 65535]
set access interface untagged <interface-name> **max-subscribers-per-vlan** [1 - 65535]
set access interface untagged <interface-name> **pppoe-pado-delay** [1 - 255]
set access interface untagged <interface-name> **redundancy-session-id** [1 - 65535]
set access interface untagged <interface-name> **service-profile-name** <service-profile-name>
set access interface untagged <interface-name> **vlan-profile-enable** [**false** | **true**]

The following tables describes the command options to configure the untagged access interface.

Attribute	Description
interface-name	Specifies the physical interface on which untagged subscriber access is configured.
aaa-profile-name	Specifies the AAA profile used for authentication, authorization, and accounting of subscribers.
access-profile-name	Associates an access profile that defines subscriber session handling and policies.
access-type	Specifies the access method for subscribers, such as PPPoE or IPoE.
dhcp-min-elapsed-time	Specifies the minimum elapsed time before accepting DHCP packets. Range: 1 - 600 seconds.
gateway-ifl	Specifies the logical interface used as the gateway for IPoE subscribers.
max-subscribers-per-mac	Limits the number of subscriber sessions allowed per MAC address. Range: 1 - 65535.

Attribute	Description
max-subscribers-per-vlan	Limits the number of subscriber sessions allowed per VLAN. Range: 1 - 65535.
pppoe-pado-delay	Configures the delay before sending PPPoE PADO responses. Range: 1 - 255 seconds.
redundancy-session-id	Assigns a session ID used for subscriber session redundancy. Range: 1 - 65535.
service-profile-name	Specifies the service profile applied to subscriber sessions.
vlan-profile-enable	Enables or disables the use of VLAN profiles for subscriber management.

Example:

In the following example configuration, the untagged access interface 'ifp-0/0/0' is configured for PPPoE access type, with the Access Profile set to 'pppoe-dual', Service Profile set to 'service-profile1', and AAA Profile set to 'aaa-radius'. The option 'vlan-profile-enable' is enabled by setting it to 'true', and the parameters 'max-subscribers-per-vlan' and 'max-subscribers-per-mac' are both assigned the value of '1'.

```
supervisor@switch: cfg> show config access interface untagged ifp-0/0/0
{
  "rtbrick-config:untagged": {
    "interface-name": "ifp-0/0/0",
    "access-type": "PPPoE",
    "access-profile-name": "pppoe-dual",
    "service-profile-name": "service-profile1",
    "aaa-profile-name": "aaa-radius",
    "vlan-profile-enable": "true",
    "max-subscribers-per-vlan": 1,
    "max-subscribers-per-mac": 1
  }
}
```



- Untagged interfaces are not supported on UfiSpace S9500-22XST (QAX) platform.
- The access interface-name can be a physical IFP or link aggregation (LAG).



To access the RESTCONF API that corresponds to this CLI, click here.

Configuring Single VLAN Tagged Interfaces

This section covers the configuration of interfaces that use a single VLAN tag (802.1Q) for subscriber identification. It allows defining a range of VLANs to support multiple subscribers over the same physical interface. This model is commonly used in broadband deployments where each VLAN represents a subscriber or service. The configuration supports flexible policy application per VLAN.

set access interface single-tagged <interface-name> <1-4094> <1-4094> **aaa-profile-name** <aaa-profile-name>
set access interface single-tagged <interface-name> <1-4094> <1-4094> **access-profile-name** <access-profile-name>
set access interface single-tagged <interface-name> <1-4094> <1-4094> **access-type** [**PPPoE** | **IPoE**]
set access interface single-tagged <interface-name> <1-4094> <1-4094> **dhcp-min-elapsed-time** [1 - 600]
set access interface single-tagged <interface-name> <1-4094> <1-4094> **gateway-ifl** <gateway-ifl>
set access interface single-tagged <interface-name> <1-4094> <1-4094> **max-subscribers-per-mac** [1 - 65535]
set access interface single-tagged <interface-name> <1-4094> <1-4094> **max-subscribers-per-vlan** [1 - 65535]
set access interface single-tagged <interface-name> <1-4094> <1-4094> **outer-vlan-encapsulation** [**802.1q** | **802.1ad**]
set access interface single-tagged <interface-name> <1-4094> <1-4094> **pppoe-pado-delay** [1 - 255]
set access interface single-tagged <interface-name> <1-4094> <1-4094> **redundancy-session-id** [1 - 65535]
set access interface single-tagged <interface-name> <1-4094> <1-4094> **service-profile-name** <service-profile-name>
set access interface single-tagged <interface-name> <1-4094> <1-4094> **vlan-profile-enable** [**false** | **true**]

Attribute	Description
interface-name	Specifies the physical interface on which subscriber access is configured.

Attribute	Description
outer-vlan-min	Defines the starting VLAN ID for the outer VLAN range. Range: 1 - 4094.
outer-vlan-max	Defines the ending VLAN ID for the outer VLAN range. Range: 1 - 4094.
aaa-profile-name	Specifies the AAA profile used for authentication, authorization, and accounting of subscribers.
access-profile-name	Associates an access profile that defines subscriber session handling and policies.
access-type	Specifies the access method for subscribers, such as PPPoE or IPoE.
dhcp-min-elapsed-time	Specifies the minimum elapsed time before accepting DHCP packets. Range: 1 - 600 seconds.
gateway-ifl	Specifies the logical interface used as the gateway for IPoE subscribers.
max-subscribers-per-mac	Limits the number of subscriber sessions allowed per MAC address. Range: 1 - 65535.
max-subscribers-per-vlan	Limits the number of subscriber sessions allowed per VLAN. Range: 1 - 65535.
outer-vlan-encapsulation	Specifies the encapsulation type for the outer VLAN (for example, 802.1Q or 802.1ad).
pppoe-pado-delay	Configures the delay before sending PPPoE PADO responses. Range: 1 - 255 seconds.
redundancy-session-id	Assigns a session ID used for subscriber session redundancy. Range: 1 - 65535.
service-profile-name	Specifies the service profile applied to subscriber sessions.
vlan-profile-enable	Enables or disables the use of VLAN profiles for subscriber management.

You need to define the VLAN identifier range within the range from 128 to 4000 for VLAN tagged interface. The following command and options are used to configure a single VLAN-tagged interface.

In the following example, the single tagged access interface ifp-0/0/0 is configured

with the Outer VLAN minimum value 128 and the outer VLAN maximum value 3000. The Access Type is defined PPPoE, Access Profile pppoe-dual, and AAA Profile as aaa-radius.

```
supervisor@switch: cfg> set access interface single-tagged ifp-0/0/0 128 3000
access-type PPPoE
supervisor@switch: cfg> set access interface single-tagged ifp-0/0/0 128 3000
access-profile-name pppoe-dual
supervisor@switch: cfg> set access interface single-tagged ifp-0/0/0 128 3000 aaa-
profile-name aaa-radius
supervisor@switch: cfg> commit
supervisor@switch: cfg> show config access interface single-tagged ifp-0/0/0 128
3000
{
  "rtbrick-config:single-tagged": [
    {
      "interface-name": "ifp-0/0/0",
      "outer-vlan-min": 128,
      "outer-vlan-max": 3000,
      "access-type": "PPPoE",
      "access-profile-name": "pppoe-dual",
      "aaa-profile-name": "aaa-radius"
    }
  ]
}
```



The access interface-name can be a physical IFP or LAG.



To access the RESTCONF API that corresponds to this CLI, click here.

Configuring Double Tagged VLAN Interfaces

This section describes how to configure interfaces using double VLAN tagging (Q-in-Q or 802.1ad). Double tagging enables hierarchical subscriber identification using outer (service) and inner (customer) VLANs. It is widely used in large-scale broadband networks to support multi-tenant or wholesale models. The configuration provides greater scalability and flexibility in subscriber and service separation.



When configuring double-tagged VLAN interfaces, setting the minimum and maximum VLAN ID to the same value ensures that only a specific VLAN ID is matched. It indicates that the VLAN interface will specifically recognize and process traffic tagged with that exact VLAN ID.

Syntax:

set access interface double-tagged <interface-name> <1-4094> <1-4094> <1-4094> <1-4094> **aaa-profile-name** <aaa-profile-name>
set access interface double-tagged <interface-name> <1-4094> <1-4094> <1-4094> <1-4094> **access-profile-name** <access-profile-name>
set access interface double-tagged <interface-name> <1-4094> <1-4094> <1-4094> <1-4094> **access-type** [**PPPoE** | **IPoE**]
set access interface double-tagged <interface-name> <1-4094> <1-4094> <1-4094> <1-4094> **dhcp-min-elapsed-time** [1 - 600]
set access interface double-tagged <interface-name> <1-4094> <1-4094> <1-4094> <1-4094> **gateway-ifl** <gateway-ifl>
set access interface double-tagged <interface-name> <1-4094> <1-4094> <1-4094> <1-4094> **max-subscribers-per-mac** [1 - 65535]
set access interface double-tagged <interface-name> <1-4094> <1-4094> <1-4094> <1-4094> **max-subscribers-per-vlan** [1 - 65535]
set access interface double-tagged <interface-name> <1-4094> <1-4094> <1-4094> <1-4094> **outer-vlan-encapsulation** [**802.1q** | **802.1ad**]
set access interface double-tagged <interface-name> <1-4094> <1-4094> <1-4094> <1-4094> **pppoe-pado-delay** [1 - 255]
set access interface double-tagged <interface-name> <1-4094> <1-4094> <1-4094> <1-4094> **redundancy-session-id** [1 - 65535]
set access interface double-tagged <interface-name> <1-4094> <1-4094> <1-4094> <1-4094> **service-profile-name** <service-profile-name>
set access interface double-tagged <interface-name> <1-4094> <1-4094> <1-4094> <1-4094> **vlan-profile-enable** [**false** | **true**]

The following commands and options are used to configure double-tagged VLAN interfaces.

Attribute	Description
interface-name	Specifies the physical interface on which double-tagged subscriber access is configured.
outer-vlan-min	Defines the starting VLAN ID for the outer VLAN range. Range: 1 - 4094.
outer-vlan-max	Defines the ending VLAN ID for the outer VLAN range. Range: 1 - 4094.

Attribute	Description
inner-vlan-min	Defines the starting VLAN ID for the inner VLAN range. Range: 1 - 4094.
inner-vlan-max	Defines the ending VLAN ID for the inner VLAN range. Range: 1 - 4094.
aaa-profile-name	Specifies the AAA profile used for authentication, authorization, and accounting of subscribers.
access-profile-name	Associates an access profile that defines subscriber session handling and policies.
access-type	Specifies the access method for subscribers, such as PPPoE or IPoE.
dhcp-min-elapsed-time	Specifies the minimum elapsed time before accepting DHCP packets. Range: 1 - 600 seconds.
gateway-ifl	Specifies the logical interface used as the gateway for IPoE subscribers.
max-subscribers-per-mac	Limits the number of subscriber sessions allowed per MAC address. Range: 1 - 65535.
max-subscribers-per-vlan	Limits the number of subscriber sessions allowed per VLAN. Range: 1 - 65535.
outer-vlan-encapsulation	Specifies the encapsulation type for the outer VLAN (for example, 802.1Q or 802.1ad).
pppoe-pado-delay	Configures the delay before sending PPPoE PADO responses. Range: 1 - 255 seconds.
redundancy-session-id	Assigns a session ID used for subscriber session redundancy. Range: 1 - 65535.
service-profile-name	Specifies the service profile applied to subscriber sessions.
vlan-profile-enable	Enables or disables the use of VLAN profiles for subscriber management.

In the following example, the double-tagged access interface ifp-0/0/0 is configured with the Outer VLAN minimum value 128 and the outer VLAN maximum value 3000. The configuration also defines the inner VLAN minimum value 7 and Inner VLAN maximum value 7. The Access Type is defined PPPoE,

Access Profile pppoe-dual, and AAA Profile aaa-radius.

```
supervisor@switch: cfg> set access interface double-tagged ifp-0/0/0 128 3000 7 7
access-type PPPoE
supervisor@switch: cfg> set access interface double-tagged ifp-0/0/0 128 3000 7 7
access-profile-name pppoe-dual
supervisor@switch: cfg> set access interface double-tagged ifp-0/0/0 128 3000 7 7
aaa-profile-name aaa-radius
supervisor@switch: cfg> commit
supervisor@switch: cfg> show config access interface single-tagged ifp-0/0/0 128
3000 7 7
{
  "rtbrick-config:double-tagged": {
    "interface-name": "ifp-0/0/0",
    "outer-vlan-min": 128,
    "outer-vlan-max": 3000,
    "inner-vlan-min": 7,
    "inner-vlan-max": 7,
    "access-type": "PPPoE",
    "access-profile-name": "pppoe-dual",
    "aaa-profile-name": "aaa-radius"
  }
}
```



The access interface-name can be a physical IFP or LAG.

The following example sets a PPPoE PADO delay of 30 seconds for a double-tagged interface ifp-0/0/0.

```
set access interface double-tagged ifp-0/0/0 201 250 201 250
set access interface double-tagged ifp-0/0/0 201 250 201 250 access-type PPPoE
set access interface double-tagged ifp-0/0/0 201 250 201 250 access-profile-name
pppoe-default-ds
set access interface double-tagged ifp-0/0/0 201 250 201 250 aaa-profile-name aaa-
profile
set access interface double-tagged ifp-0/0/0 201 250 201 250 pppoe-pado-delay 30
```



To access the RESTCONF API that corresponds to this CLI, click here.

Access Profile Configuration

You must configure an access interface with an access profile name, such as pppoe-dual and it is also essential to configure the properties and parameters of the access profile itself.

The following image illustrates the access interface configurations and how they are associated with the entire subscriber management configurations.

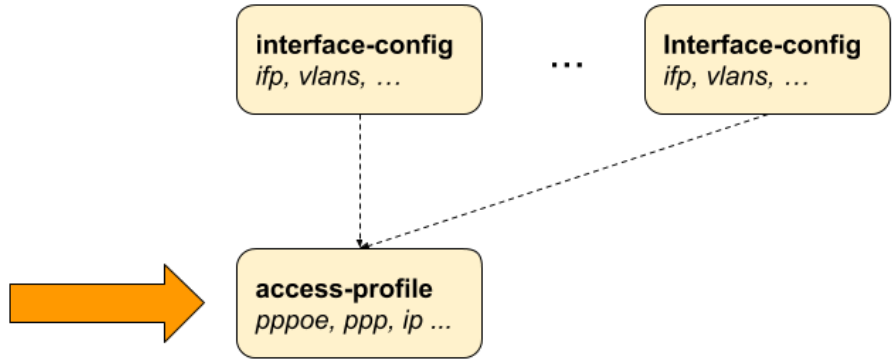


Figure 67. Access Profile Configuration

Configuring the Access Profile

Configuring an access profile involves specifying its name and defining various parameters to control how it handles network traffic and client interactions. The following command and options allow you to configure an access profile.

set access access-profile <profile-name>
set access access-profile <profile-name> **address-family**
set access access-profile <profile-name> **instance**
set access access-profile <profile-name> **protocol**

The following table provides the command options/attributes and descriptions.

Attribute	Description
-	Without any option, the command creates an access profile.
<profile-name>	Name of the access profile.
instance	Name of the outing instance. Default instance value is 'default'. The instance attribute in the access profile specifies the routing instance for PPPoE subscribers. For IPoE subscribers, the routing instance is determined by the 'gateway-ifl' parameter.
address-family	Address-family configuration
protocol	Protocol configuration.

PPPoE with IPv4 and IPv6

The following access profile configuration is a PPPoE access profile named pppoe-

dual that supports both IPv4 and IPv6. The instance is marked as default, and the session protection is enabled for PPPoE by setting the value to true, and the VLAN priority is set to 6.

The configuration defines various PPP parameters such as LCP, IPCP, and so on. For LCP (Link Control Protocol), the authentication protocol is specified as PAP_CHAP, indicating that both PAP (Password Authentication Protocol) and CHAP (Challenge Handshake Authentication Protocol) are allowed. The echo-interval, which is the interval in seconds for sending LCP echo requests to check the connection, is specified as 30 seconds. The echo-max-retransmit parameter, which is the maximum number of retransmissions for LCP echo requests before considering the link down, is set to 3. The configuration enables the LCP echo requests by specifying true for the echo-enable parameter.

In the configuration, both the IPCP and IP6CP are enabled by setting their values to true. These protocols are used to configure both the IPv4 and IPv6 settings over PPP. The source IFL (logical interface) for IPCP is specified as 'lo-0/0/0/1'. The RA (Router Advertisement) Configuration is enabled by setting the value to 'true', which allows the router to send RA messages for IPv6 configuration. The interval period for the RA messages is set to 60 seconds. DHCPv6 is enabled by setting the value to true, which allows the device to assign IPv6 addresses to the subscribers through DHCP.

The L2TP tunnel profile is defined as l2tp-default, which allows the encapsulation of PPP sessions over IP networks. Both IPv4 and IPv6 address families are enabled by setting their values to true using the address family configurations. For IPv4, the primary DNS server is specified '198.51.100.1' and the secondary DNS server is specified '198.51.100.4'. For IPv6, the primary DNS server is specified as '2001:db8:0:100::'' and the secondary DNS server is specified '2001:db8:0:104::'.

```
supervisor@switch: cfg> show config access access-profile pppoe-dual
{
  "rtbrick-config:access-profile": {
    "profile-name": "pppoe-dual",
    "instance": "default",
    "protocol": {
      "pppoe": {
        "enable": "true",
        "session-protection": {
          "enable": "true"
        },
        "vlan-priority": 6
      },
      "ppp": {
        "lcp": {
```

```
          "authentication-protocol": "PAP_CHAP",
          "echo-interval": 30,
          "echo-max-retransmit": 3,
          "echo-enable": "true"
        },
        "ipcp": {
          "enable": "true",
          "source-ifl": "lo-0/0/0/1"
        },
        "ip6cp": {
          "enable": "true"
        }
      },
      "ra": {
        "enable": "true",
        "interval": 60
      },
      "dhcpv6": {
        "enable": "true"
      },
      "l2tp": {
        "tunnel-profile": "l2tp-default"
      }
    },
    "address-family": {
      "ipv4": {
        "enable": "true",
        "primary-dns": "198.51.100.1",
        "secondary-dns": "198.51.100.4"
      },
      "ipv6": {
        "enable": "true",
        "primary-dns": "2001:db8:0:100::",
        "secondary-dns": "2001:db8:0:104::"
      }
    }
  }
}
```

IPoE with IPv4 and IPv6

The example configuration below sets up an IPoE access profile named 'ipoe-dual' to handle IPoE sessions, which support both IPv4 and IPv6 address families. The router acts as a DHCP server for both protocols, assigning IP addresses and DNS server information to client devices.

The profile name is ipoe-dual. By setting the value to true, this profile enables both DHCP and DHCPv6 protocols. The mode is defined as server for both DHCP and DHCPv6, which allows the router to act as a server for IPv4 and IPv6. The IPv4 address family is configured for the access profile by setting the value to true. For IPv4, proxy ARP is enabled by setting proxy-arp-enable to true.

The IPv4 address family is configured for the access profile by setting the value to

‘true. For IPv4, proxy ARP is enabled by setting proxy-arp-enable to true. This allows the router to respond to ARP requests on behalf of other hosts.

The pool name ipoe indicates the IPv4 address allocation to client devices. The primary DNS server for IPv4 is set to '198.51.100.1', and the secondary DNS server is specified as '198.51.100.4'.

The configuration includes various parameters for IPv6. The IPv6 pool name is ipoe-ia-na, which provides IPv6 addresses to subscribers. The prefix-delegation-pool-name parameter is set as ipoe-ia-pd for IPv6 prefix delegation. The primary and secondary DNS servers for IPv6 are specified as '2001:db8:0:100::' and '2001:db8:0:104::' respectively.

```
supervisor@switch: cfg> show config access access-profile ipoe-dual
{
  "rtbrick-config:access-profile":{
    "profile-name":"ipoe",
    "protocol":{
      "dhcp":{
        "enable":"true",
        "mode":"server"
      },
      "dhcpv6":{
        "enable":"true",
        "mode":"server"
      }
    },
    "address-family":{
      "ipv4":{
        "enable":"true",
        "proxy-arp-enable": "true",
        "pool-name":"ipoe",
        "primary-dns":"198.51.100.1,
        "secondary-dns":"198.51.100.4"
      },
      "ipv6":{
        "enable":"true",
        "pool-name":"ipoe-ia-na",
        "prefix-delegation-pool-name":"ipoe-ia-pd",
        "primary-dns": "2001:db8:0:100::",
        "secondary-dns": "2001:db8:0:104::"
      }
    }
  }
}
```

Unrestricted Proxy-ARP Support for Subscriber IFLs Configuration

This configuration option allows subscriber IFLs to enable unrestricted proxy-ARP, which responds to all ARP requests from subscribers using the MAC address of the corresponding subscriber IFL

Syntax:

set access access-profile <access-profile1> **address-family ipv4 proxy-arp** [**any** | **disabled** | **subscriber**]

Attribute
Description
<access-profile1>
Specifies the name of the access profile.
address-family ipv4
Indicates that the configuration applies to the IPv4 address family.
proxy-arp
Enables and controls proxy ARP functionality for the access profile.
any
Allows the device to respond to ARP requests for any IP address, regardless of whether it belongs to a known subscriber.
subscriber
Allows the device to respond only to ARP requests for known subscriber IP addresses.
disabled
Disables Proxy ARP functionality for the access profile.

Sample command:

```
set access access-profile access-profile1 address-family ipv4 proxy-arp any
```

Example:

```
supervisor@rtbrick: cfg> show config access access-profile access-profile1
{
  "rtbrick-config:access-profile": [
    {
      "profile-name": "access-profile1",
      "protocol": {
        "ra": {
          "enable": "true"
```

```
        },
        "dhcp": {
          "enable": "true",
          "mode": "server"
        },
        "dhcpv6": {
          "enable": "true",
          "mode": "server"
        }
      },
      "address-family": {
        "ipv4": {
          "enable": "true",
          "pool-name": "pool1",
          "proxy-arp": "any"
        },
        "ipv6": {
          "enable": "true",
          "pool-name": "pool1",
          "prefix-delegation-pool-name": "pool2",
          "primary-dns": "1::1"
        }
      }
    }
  ]
}
```

API To access the RESTCONF API that corresponds to this CLI, click here.

Configuring IPv4

To enable IPv4 support for access protocols like PPP (PPPoE) or DHCP (IPoE), explicitly activate the IPv4 address family in the access profile.

Syntax:

set access access-profile <profile-name> **address-family ipv4 dad-enable** [**false** | **true**]
set access access-profile <profile-name> **address-family ipv4 enable** [**false | true**]
set access access-profile <profile-name> **address-family ipv4 pool-name** [**pool** - **name**]
set access access-profile <profile-name> **address-family ipv4 primary-dns** [**primary** - **dns**]
set access access-profile <profile-name> **address-family ipv4 proxy-arp** [**disabled** | **subscriber** | **any**]
set access access-profile <profile-name> **address-family ipv4 proxy-arp-enable** [**false** | **true**]

set access access-profile <profile-name> **address-family ipv4 secondary-dns** [**secondary-dns**]
set access access-profile <profile-name> **address-family ipv4 static-ipv4** [**static-ipv4**]

The following table provides the command options/attributes and descriptions.

Attribute	Description
enable	Enable IPv4. Default: false.
pool-name	The pool-name option (optional) allows assigning the IPv4 address from a locally managed pool. For more details, see Address Pool Configuration. This address is used by protocols like PPP IPCP (PPPoE) or DHCP (IPoE) as a client or peer IPv4 address.
primary-dns	Primary DNS server.
secondary-dns	The primary DNS and secondary DNS servers configured are used by protocols such as PPP (PPPoE) or DHCP (IPoE) and advertised to the client.
proxy-arp-enable	Enable (or disable) proxy ARP support for IPoE subscribers. When proxy ARP is enabled, if the RBFS device receives an ARP request from the subscriber for which it has a route to the target (destination) IP address, the RBFS device responds by sending a proxy ARP reply packet containing its own MAC address. The host/subscriber that sent the ARP request then sends the actual destined packets to RBFS, which forwards them to the intended destination. Default: NONE.
static-ipv4	The static-ipv4 attribute is used to configure a fixed IPv4 address for all clients connected under a specific access profile. This is particularly useful in scenarios requiring a consistent IP address for services.  This feature should be used with caution.

 To access the RESTCONF API that corresponds to this CLI, click here.

Configuring IPv6

To make IPv6 available for access protocols such as PPP (PPPoE) or DHCP (IPoE), you must explicitly enable the IPv6 address family within the access profile.

Syntax:

set access access-profile <profile-name> **address-family ipv6 dad-enable** [**false** | **true**]
set access access-profile <profile-name> **address-family ipv6 enable** [**false** | **true**]
set access access-profile <profile-name> **address-family ipv6 pool-name** <pool-name>
set access access-profile <profile-name> **address-family ipv6 prefix-delegation-pool-name** <prefix-delegation-pool-name>
set access access-profile <profile-name> **address-family ipv6 primary-dns** <primary-dns>
set access access-profile <profile-name> **address-family ipv6 secondary-dns** <secondary-dns>

The following table provides the command options/attributes and descriptions.

Attribute	Description
enable	Enable IPv6. Default: False.
pool-name	Local IPv6 pool name.
prefix-delegation-pool-name	The pool-name attribute (optional) allows to assign of the IPv6 prefix from a locally managed pool. For more details, see Address Pool Configuration. This prefix is advertised by ICMPv6 router advertisements to the client where prefixes from optional prefix-delegation-pool-name are advertised by DHCPv6 as delegated prefix (IA_PD).
primary-dns	Primary DNS server.
secondary-dns	The primary DNS and secondary DNS servers configured are used by protocols such as ICMPv6 router advertisements or DHCPv6 and advertise to the client.

To access the RESTCONF API that corresponds to this CLI, click here.

Enabling IPv6 Router Advertisement

IPv6 Router Advertisement (RA) is a key function within the IPv6 Neighbor Discovery Protocol (NDP). Routers use RA messages to announce their presence and share essential network parameters with IPv6-capable devices. Enabling Router Advertisement is critical for the automatic configuration of IPv6 addresses and related settings on devices supporting IPv6.

set access access-profile <profile-name> **protocol ra enable** [**false** | **true**]
set access access-profile <profile-name> **protocol ra interval** [0 - 255]
set access access-profile <profile-name> **protocol ra lifetime** [0 - 4294967295]
set access access-profile <profile-name> **protocol ra preferred-lifetime** [0 - 4294967295]
set access access-profile <profile-name> **protocol ra router-lifetime** [0 - 9000]

The following table provides the command options/attributes and descriptions.

Attribute	Description
enable	Enable IPv6 router advertisement. Default: False.
interval	IPv6 router advertisements interval in seconds. Sets the interval at which the Router Advertisement messages are sent. Default: 0 ('0' indicates disabled state).
lifetime	The valid lifetime for the prefix in seconds. Default: 14400.
preferred-lifetime	The preferred lifetime for the prefix in seconds. Default: 1800.

Configuring DHCPv4

To enable and configure DHCPv4 in the access profile, use the following command. This configuration enables the access profile to process DHCP requests and assign IP addresses to clients.

Syntax:

set access access-profile <profile-name> **protocol dhcp dhcp-server** <dhcp-server>
set access access-profile <profile-name> **protocol dhcp enable** [**false** | **true**]
set access access-profile <profile-name> **protocol dhcp lease-time** [1 - 4294967295]
set access access-profile <profile-name> **protocol dhcp mode** [**server** | **relay**]

The following table provides the command options and descriptions.

Attribute	Description
-	With any option, the command sets the DHCP mode for the specified access profile.
enable	True or false. Specify true to enable DHCP. Default: False.
dhcp-mode	This option specifies the DHCP mode for handling DHCP requests. Default: server. Values: server and relay.
lease-time	Define the duration of IP address leases, in seconds. Default: 300
dhcp-server	Configure global DHCP server.

API To access the RESTCONF API that corresponds to this CLI, click here.

Configuring DHCPv6

To configure DHCPv6 in an access profile, use the following command. This configuration activates DHCPv6 functionality, sets prefix lifetimes, and defines the operating mode.

set access access-profile <profile-name> **protocol dhcpv6 dhcpv6-server** <dhcpv6-server>
set access access-profile <profile-name> **protocol dhcpv6 enable** [**false** | **true**]
set access access-profile <profile-name> **protocol dhcpv6 lifetime** [30 - 4294967295]
set access access-profile <profile-name> **protocol dhcpv6 mode** [**server** |

relay]
set access access-profile <profile-name> **protocol dhcpv6 preferred-lifetime** [30 - 4294967295]

The following table provides the command options/attributes and descriptions.

Attribute	Description
enable	Enable DHCPv6. Default: False.
mode	This option defines the DHCPv6 mode where the server handles DHCPv6 requests locally and relay/proxy forwards those to the configured servers. The difference between relay and proxy is that proxy can hide the actual DHCPv6 server. Default: server. Values: server and relay.
lifetime	The duration for which the advertised prefix is valid. This is the total time the prefix remains usable before it needs to be renewed. Set this to the desired lifetime in seconds. Default: 14400.
preferred-lifetime	Set the lifetime for IPv6 prefixes, in seconds. It defines the duration during which the prefix is preferred for use. It should be less than or equal to the lifetime. If set higher than the lifetime, it will be adjusted to match the lifetime. The values for T1 and T2 are 0.5 and 0.8 times the shortest preferred lifetime. Default: 1800.
dhcpv6-server	Configure DHCPv6 server.

API To access the RESTCONF API that corresponds to this CLI, click here.

Configuring PPPoE and PPP

The PPPoE protocol must be explicitly enabled in the access profile to allow PPPoE sessions.

PPPoE

The PPPoE configuration allows changing the default behavior of the PPPoE protocol.

set access access-profile <profile-name> **protocol pppoe enable** [**false** | **true**]
set access access-profile <profile-name> **protocol pppoe max-outstanding** <1 - 65535>
set access access-profile <profile-name> **protocol pppoe session-protection enable** [**false** | **true**]
set access access-profile <profile-name> **protocol pppoe session-protection max-lockout** [1 - 65535]
set access access-profile <profile-name> **protocol pppoe session-protection min-lockout** [1 - 255]
set access access-profile <profile-name> **protocol pppoe session-protection min-uptime** <1 - 65535>

Sample command:

```
set access access-profile pppoe-dual protocol pppoe enable true
```

The following table provides the command options/attributes and descriptions.

Attribute	Description
-	Without any option, the command sets the access protocol.
enable	Enable PPPoE. Default: False.
max-outstanding	Maximum outstanding PPPoE sessions. Default: 64 Range: 1 - 65535.

Attribute	Description
session-protection	PPPoE session protection. When PPPoE session protection is enabled, any short-lived or failed sessions are logged. By default, a session that does not remain established for at least 60 seconds (min-uptime) is classified as a failed or short-lived session. Such failures trigger a block on new sessions for this IFP, VLAN, and MAC for one second (min-lockout) by default. With each subsequent failed session, the lockout duration increases exponentially until it reaches a maximum of 300 seconds (max-lockout). If no failed sessions occur for 900 seconds, the lockout interval is reset (currently, not configurable). PPPoE session protection also logs the last subscriber ID and terminates the session with a code that indicates the reason for the failure.

Attribute	Description
-	Without any option, the command sets session protection for the access profile.
enable	Enables PPPoE session protection. Default: false.
min-lockout	Session protection minimum lockout time (in seconds). Default: 1.
max-lockout	Session protection maximum lockout time (in seconds). Default: 300.
min-uptime	Session with an uptime less than this will trigger protection (in seconds). Default: 60.



To access the RESTCONF API that corresponds to this CLI, click here.

Configuring PPP LCP

The PPP Link Control Protocol (LCP) configuration allows changing the default behavior of the LCP protocol.

Syntax:

set access access-profile <profile-name> **protocol ppp lcp authentication-protocol** [**PAP** | **CHAP** | **PAP_CHAP** | **CHAP_PAP**]
set access access-profile <profile-name> **protocol ppp lcp config-nak-max** [1 - 255]
set access access-profile <profile-name> **protocol ppp lcp echo-enable** [**false** | **true**]
set access access-profile <profile-name> **protocol ppp lcp echo-interval** [1 - 255]
set access access-profile <profile-name> **protocol ppp lcp echo-max-retransmit** [1 - 255]
set access access-profile <profile-name> **protocol ppp lcp lcp-loop-detection** [**false** | **true**]
set access access-profile <profile-name> **protocol ppp lcp mru** [1280 - 1500]
set access access-profile <profile-name> **protocol ppp lcp mru-negotiation** [**false** | **true**]
set access access-profile <profile-name> **protocol ppp lcp mtu** [1280 - 1500]
set access access-profile <profile-name> **protocol ppp lcp retransmit-interval** [1 - 255]
set access access-profile <profile-name> **protocol ppp lcp retransmit-max** [1 - 255]

The following table provides the command options and description.

Attribute	Description
authentication-protocol	This option allows you to specify the authentication protocol used during the LCP negotiation phase. By default, PPP authentication is set to PAP_CHAP. This can be changed by setting the authentication protocol to either PAP, CHAP, PAP_CHAP or CHAP_PAP. The Password Authentication Protocol (PAP) is (defined in RFC 1334) and receives the password as a plain text value from the client. The Challenge Handshake Authentication Protocol (CHAP) is (defined in RFC 1994) provides a more secure way to authenticate the client without exchanging plaintext secrets. The PAP_CHAP option first attempts to authenticate using PAP with a fallback to CHAP, if PAP is rejected by the client. Alternatively, CHAP_PAP starts with CHAP and falls back to PAP if CHAP is rejected by the client. Default: PAP_CHAP.
echo-enable	By default, RBFS responds to LCP echo requests but does not initiate them unless echo-enable is set to true. Default: true
echo-interval	LCP echo request interval in seconds. Default: 30, Range: 1 - 255.
echo-max-retransmit	LCP echo request retransmissions. Default: 3, Range: 1 - 255.
mru-negotiation	Negotiate MRU. Default: true.
mru	Maximum local MRU (peer MTU). Default: 1492, Range: 1280 - 1500.
mtu	Maximum local MTU (peer MRU). Default: 1492, Range: 1280 - 1500.

Attribute	Description
lcp-loop-detection	This is used during the PPP connection process to detect and prevent loops in the network. It is achieved through the negotiation and validation of 'magic numbers'. Magic numbers are unique values used by both ends of a PPP connection to ensure that the data sent is not simply being looped back from the other end. By default, the negotiation and validation of magic numbers are enabled, providing protection against looping connections. You can disable loop detection by setting lcp-loop-detection to false. However, it is NOT recommended to disable LCP loop detection. Default: true.
retransmit-interval	The LCP request retransmission interval. Default: 5, Range: 1 - 255.
retransmit-max	The LCP requests retransmission before the session is terminated if no response is received. Default: 3, Range: 1 - 255.
config-nak-max	The option config-nak-max defines the maximum PPP LCP configuration reject/nak messages that can be sent or received before the session is terminated. Default: 16, Range: 1 - 255.

 To access the RESTCONF API that corresponds to this CLI, click here.

Configuring PPP IPCP

To configure IPv4 over PPPoE, explicitly enable both the address-family IPv4 and the PPP IPCP protocol in the access profile. The source-ifl is a mandatory option that specifies the logical interface from which the local IPv4 address will be derived.

Syntax:

set access access-profile <profile-name> **protocol ppp ipcp config-nak-max** [1 - 255]
set access access-profile <profile-name> **protocol ppp ipcp enable** [**false** | **true**]
set access access-profile <profile-name> **protocol ppp ipcp passive** [**false**

| **true**]
set access access-profile <profile-name> **protocol ppp ipcp retransmit-interval** [1 - 255]
set access access-profile <profile-name> **protocol ppp ipcp retransmit-max** [1 - 255]
set access access-profile <profile-name> **protocol ppp ipcp source-ifl** <source-ifl>

The following table provides the command options/attributes and descriptions.

Attribute	Description
enable	Enable IPCP. Default: False.
passive	IPCP passive mode. Default: False.
source-ifl	This setting is required and should be set to obtain the local IPv4 address from a specific logical interface. It should be configured to use the loopback interface of the corresponding routing instance. If a source-ifl is chosen from a different routing instance, it will not change the routing instance assigned to the subscriber. Also, the routing instance can be changed through a RADIUS Access-Accept message without affecting the source-ifl. This means that the source-ifl can still be used to obtain the local IPv4 address, even if it belongs to a different routing instance. Although, it is not mandatory, it is recommended to configure the same loopback address across all routing instances where a subscriber might be located.
retransmit-interval	The IPCP request retransmission interval. Default: 5, Range: 1 - 255.
retransmit-max	The IPCP requests retransmission before the session is terminated if no response is received. Default: 8 Range: 1 - 255.
config-nak-max	The option config-nak-max defines the maximum PPP IPCP configuration reject/nak messages that can be sent or received before the session is terminated. Default: 8, Range: 1 - 255.

API To access the RESTCONF API that corresponds to this CLI, click here.

Configuring PPP IP6CP

To enable IPv6 over PPPoE, you must explicitly configure both the IPv6 address family and the PPP IPv6 Control Protocol (IP6CP).

set access access-profile <profile-name> **protocol ppp ip6cp config-nak-max** [1 - 255]
set access access-profile <profile-name> **protocol ppp ip6cp enable** [**false** | **true**]
set access access-profile <profile-name> **protocol ppp ip6cp passive** [**false** | **true**]
set access access-profile <profile-name> **protocol ppp ip6cp retransmit-interval** [1 - 255]
set access access-profile <profile-name> **protocol ppp ip6cp retransmit-max** [1 - 255]

The following command demonstrates how to enable PPP IP6CP in the pppoe-dual access profile.

The following table provides the command options/attributes and descriptions.

Attribute	Description
enable	Enable IP6CP. Default: false.
passive	IP6CP passive mode. Default: false.
retransmit-interval	This option sets the interval, in seconds, between retransmissions, for IP6CP requests. Default: 5 Range: 1 - 255.
retransmit-max	This option sets the maximum number of retransmission attempts. The IP6CP requests retransmission before the session is terminated if no response is received. Default: 8, Range: 1 - 255.
config-nak-max	The option defines the maximum PPP IP6CP configuration reject/nak (Negative Acknowledgement) messages that can be sent or received before the session is terminated. Default: 6, Range: 1 - 255.

API To access the RESTCONF API that corresponds to this CLI, click here.

Retention Timer for Subscriber Termination History Configuration

You can configure a retention period (in hours) for storing the termination history of access subscribers after they have been disconnected.

Syntax:

set access terminate-history-timeout [0 - 720]

Option	Description
<value>	Specify the period of time (in hours). Range: 0 - 720. If '0' is specified, the data is not retained.

Example:

```
set access terminate-history-timeout 10
```

```
{
  "rtbrick-config:access": {
    "terminate-history-timeout": 10
  }
}
```

DHCP Server Configuration

DHCPv4 and DHCPv6 server configuration allows you assign IP addresses and manage subscriber settings for IPv4 and IPv6 clients. These settings control how access devices communicate with external DHCP servers, including how to reach the server, which source address to use.

Configuring DHCPv4 Server

You can configure the DHCP server for IP address allocation using the following command and options.

Syntax:

set access dhcp-server <server-name> **address** <address>
set access dhcp-server <server-name> **routing-instance** <routing-

instance>
set access dhcp-server <server-name> **source-address** <source-address>

Attribute	Description
-	Without any option, the command configures a DHCPv6 server instance with the specified name.
address	Specifies the global DHCPv4 server IP address.
routing-instance	Defines the routing instance through which the DHCPv4 server is reachable.
source-address	Specifies the source IPv4 address used for DHCPv4 packets.

The following example shows a DHCPv4 server configuration. It indicates the DHCP server name as 'dhcp-server1', which is the identifier for the DHCP server. The DHCP server's IP address is specified as '172.16.0.10', and the source IP address is specified as '172.16.0.2', which is used by the DHCP server when sending out packets. The routing instance name is set as 'default', which indicates that the DHCP server is accessible through the default instance.

```
supervisor@switch: cfg> show config access dhcp-server
{
  "rtbrick-config:dhcp-server": [
    {
      "server-name": "dhcp-server1",
      "address": "172.16.0.10",
      "source-address": "172.16.0.2",
      "routing-instance": "default"
    }
  ]
}
```

API To access the RESTCONF API that corresponds to this CLI, click here.

Configuring DHCPv6 Server

The following commands and options are used to configure a DHCPv6 server.

Syntax:

set access dhcpv6-server <server-name> **address** <address>
set access dhcpv6-server <server-name> **routing-instance** <routing-instance>

set access dhcpv6-server <server-name> **source-address** <source-address>

Attribute	Description
-	Without any option, the command creates a DHCPv6 server configuration.
address	Specifies the DHCPv6 server address.
routing-instance	Specifies the routing instance from which the DHCPv6 server is reachable.
source-address	Specifies the source address used for DHCPv6 packets.

The following example shows a DHCPv6 configuration. It shows the DHCPv6 server name is specified as ‘dhcpv6-server1’ which is the identifier for the DHCPv6 server. The IP address is specified as '172:16::2'. The source IP address is specified as '172:16::10', which is used by the DHCPv6 server when sending out packets. The routing instance name is set as 'default'. It indicates the DHCPv6 server is accessible through the default instance.

```
supervisor@switch: cfg> show config access dhcpv6-server
{
  "rtbrick-config:dhcpv6-server": [
    {
      "server-name": "dhcpv6-server1",
      "address": "172:16::2",
      "source-address": "172:16::10",
      "routing-instance": "default"
    }
  ]
}
```

API To access the RESTCONF API that corresponds to this CLI, click here.

AAA Profile Configuration

Table: global.access.aaa.profile.config

The AAA profile for subscriber access is a mandatory configuration that serves as a cornerstone for managing and tracking subscriber activities. It ensures that all subscribers are authenticated before accessing services, authorized to use those services, and accounted for billing and monitoring purposes.

The following diagram illustrates how the AAA profile is associated with various subscriber management tasks.

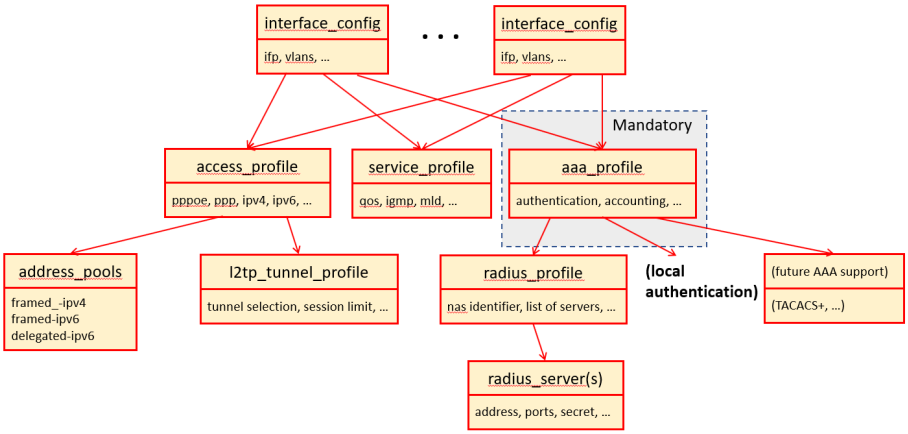


Figure 68. AAA Profile Configuration

Configuring the AAA Profile

The following command and options configure an AAA profile, which defines authentication, authorization, and accounting parameters for subscriber access.

Syntax:

set access aaa-profile <profile-name> **accounting egress byte-adjustment-factor** [0.00 - 2.00]
set access aaa-profile <profile-name> **accounting egress accounting-source** [**IFL** | **CLASS**]
set access aaa-profile <profile-name> **aaa-radius-profile** <aaa-radius-profile>
set access aaa-profile <profile-name> **accounting egress byte-adjustment-value** [-32 - 32]
set access aaa-profile <profile-name> **accounting egress class-byte-adjustment-factor** [0.00 - 2.00]
set access aaa-profile <profile-name> **accounting egress class-byte-adjustment-value** [-32 - 32]
set access aaa-profile <profile-name> **accounting ingress accounting-source** [**IFL** | **POLICER**]
set access aaa-profile <profile-name> **accounting ingress byte-adjustment-factor** [0.00 - 2.00]
set access aaa-profile <profile-name> **accounting ingress byte-**

adjustment-value [-32 - 32]
set access aaa-profile <profile-name> **accounting ingress policer-byte-adjustment-factor** [0.00 - 2.00]
set access aaa-profile <profile-name> **accounting ingress policer-byte-adjustment-value** [-32 - 32]
set access aaa-profile <profile-name> **accounting interim-interval** <interim-interval>
set access aaa-profile <profile-name> **accounting order** [**NONE** | **RADIUS**]
set access aaa-profile <profile-name> **accounting session-id-format** [**DEFAULT** | **BRIEF** | **EXTENSIVE**]
set access aaa-profile <profile-name> **authentication order** [**NONE** | **LOCAL** | **RADIUS** | **LOCAL_RADIUS**]
set access aaa-profile <profile-name> **idle-timeout** <idle-timeout>
set access aaa-profile <profile-name> **session-timeout** <session-timeout>

Attribute	Description
<profile-name>	Name of the AAA profile.
accounting egress byte-adjustment-factor	Specifies a factor applied to egress byte counters for accounting adjustment.
accounting egress accounting-source <IFL | CLASS>	Specifies the source for egress accounting counters: IFL: Interface-level counters CLASS: Class-based counters (QoS classes).
aaa-radius-profile	Specifies the RADIUS profile associated with this AAA profile.
accounting egress byte-adjustment-value 32 - 32>	Specifies an additive adjustment value applied to egress byte counters.
class-byte-adjustment-factor <0.00-2.00>	Specifies a multiplicative adjustment factor for class-based egress byte counters.
class-byte-adjustment-value 32-32>	Specifies an additive adjustment value for class-based egress byte counters.
accounting ingress accounting-source <IFL | POLICER>	Specifies the source for ingress accounting counters. Options include: IFL: Interface-level counters POLICER: Policer-based counters.

Attribute	Description
accounting ingress byte-adjustment-factor <0.00 - 2.00>	Specifies a multiplicative adjustment factor for ingress byte counters.
accounting ingress byte-adjustment-value 32 - 32>	Specifies an additive adjustment value for ingress byte counters.
accounting ingress policer-byte-adjustment-factor <0.00-2.00>	Specifies a multiplicative adjustment factor for policer-based ingress byte counters.
accounting ingress policer-byte-adjustment-value 32-32>	Specifies an additive adjustment value for policer-based ingress byte counters.
accounting interim-interval <interim-interval>	Specifies the interval (in seconds) for sending interim accounting updates to the RADIUS server.
accounting order <NONE | RADIUS>	Specifies the accounting method. RADIUS enables RADIUS accounting, while NONE disables accounting.
accounting session-id-format <DEFAULT | BRIEF | EXTENSIVE>	Defines the format of the session ID included in accounting records.
authentication order <NONE | LOCAL | RADIUS | LOCAL_RADIUS>	Specifies the authentication method and order. The options include: LOCAL: Local authentication RADIUS: RADIUS authentication LOCAL_RADIUS: Local first, then RADIUS NONE: No authentication
idle-timeout <idle-timeout>	Specifies the idle timeout in seconds. A value of 0 disables the idle timeout.
session-timeout <session-timeout>	Specifies the maximum session duration in seconds. A value of 0 disables the session timeout.
accounting	Configures accounting parameters for subscriber sessions.
authentication	Configures authentication parameters for subscriber access.

Attribute	Description
session-timeout	The session timeout defines the maximum (uptime) duration, in seconds, that a subscriber can remain connected before the session is automatically terminated. The value '0' indicates that the session has no time limit and can continue indefinitely. Default: 0, Range: 0 - 4294967295.
idle-timeout	The idle timeout is the time, in seconds, after which a subscriber will be disconnected if no data is being transmitted through their outgoing logical interface (IFL). Control traffic is not included in these statistics. The subscriber is not considered idle as long as outgoing traffic is detected. The idle timeout is not limited but should be set to at least double the time of the logical interface statistics counter update interval (between 5 to 45 seconds). The idle timeout does not have a specific limit, but it is recommended to set it to at least double the time of the logical interface statistics counter update interval (which is between 5 to 45 seconds). Therefore, it is advisable to set a minimum idle timeout of 90 seconds. The value '0' means that the timeout is infinite Default: 0, Range: 0 - 4294967295
aaa-radius-profile	The RADIUS profile, (for more details, see RADIUS Profile Configuration), which is used if RADIUS authentication or accounting is enabled.



To access the RESTCONF API that corresponds to this CLI, click here.

Example:

This following example presents a AAA (Authentication, Authorization, and Accounting) profile configuration for RADIUS authentication and accounting. The profile name is 'aaa-radius.

The session-timeout value is set to '0', meaning there is no session timeout and the session can remain active indefinitely. The idle timeout value is also '0', indicating no idle timeout, so the session will not be terminated due to inactivity.

The parameter aaa-radius-profile is set to 'radius-default', which maps the AAA profile to the specific RADIUS profile named 'radius-default'. The RADIUS profile contains the necessary configuration details for communicating with the RADIUS server. In this profile, RADIUS is the selected method for handling all authentication requests. The order parameter indicates that RADIUS is the primary and only method of authentication configured.

For accounting, the order is specified as RADIUS, indicating that all accounting data is sent to the RADIUS server.

The ingress accounting-source is "POLICER", and the egress accounting source is "CLASS". "POLICER" indicates that the accounting data is based on a traffic policer, while "CLASS" indicates that the accounting data is based on traffic classes.

The class-byte-adjustment-value parameter is set to 16, adjusting the byte count for outgoing traffic by a specific value (16).

```
supervisor@switch: cfg> show config access aaa-profile aaa-radius
{
  "rtbrick-config:aaa-profile": {
    "profile-name": "aaa-radius",
    "session-timeout": 0,
    "idle-timeout": 0,
    "aaa-radius-profile": "radius-default",
    "authentication": {
      "order": "RADIUS"
    },
    "accounting": {
      "order": "RADIUS",
      "session-id-format": "DEFAULT",
      "ingress": {
        "accounting-source": "POLICER"
      },
      "egress": {
        "accounting-source": "CLASS",
        "class-byte-adjustment-value": 16
      }
    }
  }
}
```

Configuring Authentication

RBFS supports the authentication methods: NONE, LOCAL, RADIUS and LOCAL_RADIUS.

- NONE: Disables authentication, accepting all credentials without verification.

- LOCAL: Authenticates the subscriber based on locally defined user profiles. For more details, refer to User Profile Configuration.
- RADIUS: Authenticates the subscriber remotely by sending an authentication request to the configured RADIUS servers.
- LOCAL_RADIUS: Authenticates the subscriber based on locally defined user profiles. If no matching local user is found, the system attempts authentication via RADIUS. If a local user is found but the password does not match, the subscriber is immediately rejected, and no RADIUS request is made.

Syntax:

set access aaa-profile <profile-name> **authentication order** [NONE | LOCAL | RADIUS | LOCAL_RADIUS]

The following command and options allow you to define the order of authentication methods.

```
set access aaa-profile aaa-profile1 authentication order LOCAL_RADIUS
```

Attribute	Description
order <NONE | LOCAL | RADIUS | LOCAL_RADIUS>	This option defines the order of authentication methods. The options include NONE, LOCAL, RADIUS, and LOCAL_RADIUS. Default: NONE.

API To access the RESTCONF API that corresponds to this CLI, click here.

Configuring Accounting

Subscriber accounting involves tracking and recording a subscriber session duration and data usage. This process includes two main components:

- Time Accounting: Measures the duration of a subscriber's session.
- Volume Accounting: Tracks the number of packets and bytes transmitted or received.

Volume accounting operates in both directions (ingress and egress), and these can be configured independently.

Currently, RBFS supports RADIUS as the only accounting method.

Syntax:

set access aaa-profile <profile-name> **accounting egress accounting-source** [**IFL** | **CLASS**]
set access aaa-profile <profile-name> **accounting egress byte-adjustment-factor** [0.00 - 2.00]
set access aaa-profile <profile-name> **accounting egress byte-adjustment-value** [-32 - 32]
set access aaa-profile <profile-name> **accounting egress class-byte-adjustment-factor** [0.00 - 2.00]
set access aaa-profile <profile-name> **accounting egress class-byte-adjustment-value** 32 - 32>
set access aaa-profile <profile-name> **accounting ingress accounting-source** [**IFL** | **POLICER**]
set access aaa-profile <profile-name> **accounting ingress byte-adjustment-factor** [0.00 - 2.00]
set access aaa-profile <profile-name> **accounting ingress byte-adjustment-value** [-32 - 32]
set access aaa-profile <profile-name> **accounting ingress policer-byte-adjustment-factor** [0.00 - 2.00]
set access aaa-profile <profile-name> **accounting ingress policer-byte-adjustment-value** [-32 - 32]
set access aaa-profile <profile-name> **accounting interim-interval** <interim-interval>
set access aaa-profile <profile-name> **accounting order** [**NONE** | **RADIUS**]
set access aaa-profile <profile-name> **accounting session-id-format** [**DEFAULT** | **BRIEF** | **EXTENSIVE**]

Attribute	Description
-	Without any option, it sets accounting for the AAA profile.
egress	Egress volume accounting.
ingress	Ingress volume accounting option
order	This option defines the order of accounting methods. Default: NONE.

Attribute	Description
accounting-source [IFL | CLASS]	Specifies the source of egress accounting counters. The available options include: IFL (specifies Interface-level counters) and CLASS (specifies Class-based (QoS class) counters.
byte-adjustment-factor	Adjusts egress byte counters to account for header overheads. It multiplies the byte count. For example, 1.10 adds a 10% overhead to the reported usage.
byte-adjustment-value	Adjusts egress byte counters to account for header overheads. Adds a fixed number of bytes per packet.
class-byte-adjustment-factor	configure byte counter correction for class-based (QoS class) egress accounting. Applies byte adjustments specifically to class-based (QoS) egress accounting counters.
class-byte-adjustment-value	Adds or subtracts a fixed number of bytes per packet from the class-based egress byte counter.
policer-byte-adjustment-factor	Applies byte adjustment to ingress policer counters. Specifically adjusts the math only when the source is the POLICER. Parameters are applied only when ingress accounting-source is set to POLICER.
policer-byte-adjustment-value	Applies byte adjustment to ingress policer counters. Specifically adjusts the math only when the source is the POLICER. Parameters are applied only when ingress accounting-source is set to POLICER.
session-id-format	The format of the accounting session identifier included in AAA records. EXTENSIVE includes detailed session context for enhanced correlations.
interim-interval	The interim interval specifies the time between interim accounting requests in seconds. Sets how often the device sends update packets to the accounting server during an active session. If set to 60, the server gets a usage update every 60 seconds. 0 means disabled. Default: 0, Range: 0 - 4294967295.

API To access the RESTCONF API that corresponds to this CLI, click here.

Configuring Accounting Adjustments

The accounting adjustment feature enables basic counter modifications for the configured accounting method, such as RADIUS accounting. This configuration is necessary to normalize counters across different platforms in each direction. On Broadcom Q2C and Q2A based platforms, packets are counted in the size they enter the switch. Without adjustment, egress accounting would count downstream traffic as received from the core, complete with MPLS labels, while ingress accounting typically includes VLAN headers and/or PPPoE headers.

This counter adjustment aims to normalize counters with diverse encapsulations (double-tagged, untagged, and so on), potentially aligning to L3 counters (IP header and payload) as an example, or exclusively adapting egress traffic to match the outgoing packet encapsulation. The possibility for separate adjustment configurations per direction allows parity in the counters for both ingress and egress.

In a scenario where packets enter a device with various encapsulations like PPPoE headers, MPLS labels, or VLAN tags, the system may count these additional headers in the packet size if the adjustment feature is not enabled. This can cause discrepancies in accounting reports.

For instance, an egress interface where traffic exits the device and goes to subscribers. If this traffic originally came from the core network with MPLS labels attached, the system counts the bytes of those labels in its accounting, inflating the byte count. Similarly, on the ingress side, the device counts VLAN tags or PPPoE headers, further impacting accurate accounting reports. To address this issue, you can configure a byte adjustment on both the ingress and egress sides to normalize these counters.

In RBFS, two configuration options are available for to achieve this: the byte adjustment value and the byte adjustment factor. The option byte adjustment value, which can be positive or negative (for example, -20 or 20), adjusts the byte count by a specific amount. Any decimal digits in the adjustment value are rounded to the nearest whole number (for example, 20.2 becomes 20). The option byte adjustment factor, which is less commonly used, adjusts the byte count by a percentage. It accepts positive values and considers up to two decimal places, such as 0.98 for a 2% reduction or 1.02 for a 2% increase.

Ingress Accounting

The ingress accounting configuration defines how incoming traffic counters are collected and adjusted for AAA accounting for the specified AAA profile. Subscriber ingress accounting refers to the process of measuring and recording the data usage or traffic that enters a subscriber interface (upstream).

Syntax:

set access aaa-profile <profile-name> **accounting ingress accounting-source** [**IFL** | **POLICER**]
set access aaa-profile <profile-name> **accounting ingress byte-adjustment-factor** [0.00 - 2.00]
set access aaa-profile <profile-name> **accounting ingress byte-adjustment-value** [-32 - 32]
set access aaa-profile <profile-name> **accounting ingress policer-byte-adjustment-factor** [0.00 - 2.00]
set access aaa-profile <profile-name> **accounting ingress policer-byte-adjustment-value** [-32 - 32]

The following command options allow you to set data usage accounting for incoming traffic.

Attribute	Description
accounting-source	This option provides control over the counters used for subscriber ingress accounting when RADIUS accounting is enabled. The counters in question are the RADIUS attributes Acct-Input-Packets (47), Acct-Input-Octets (42), and Acct-Input-Gigawords (52). By default, the policer statistics (POLICER) are utilized, which represent the total traffic accepted across all policer levels (1-4). However, ingress control traffic is subject to a separate control plane policer and is therefore not included in the session policer statistics. Consequently, policers are necessary if session accounting is required. Alternatively, the logical interface (IFL) statistics can be used, which capture all received traffic, including control traffic and the traffic that is dropped by the ingress policer. It is important to note that this option may NOT be available on all platforms. Default: POLICER, Supported values: POLICER and IFL.
byte-adjustment-value	Adjusts ingress IFL counters by +/- N bytes per packet. It allows you to adjust the ingress IFL counters by adding or subtracting a specified number of bytes per packet. Default: 0.00, Range: -32 to 32
byte-adjustment-factor	Adjust the ingress IFL counters by applying a specified factor. (This adjustment is made after the byte-adjustment-value is applied). Default: 1.00 Range: 0.00 - 2.00.
policer-byte-adjustment-value	Adjusts ingress POLICER counters by +/- N bytes per packet. It adjusts the ingress POLICER counters by adding or subtracting a specified number of bytes per packet. Default: 0.00 Range: -32 to 32
policer-byte-adjustment-factor	Adjusts the ingress POLICER counters by applying a specified factor. This adjustment is also executed after the policer-byte-adjustment-value is applied. Default: 1.00 Range: 0.00 - 2.00.

Egress Accounting

Subscriber egress accounting refers to the process of measuring and recording the data usage or traffic that is sent from a subscriber interface (downstream).

Syntax:

set access aaa-profile <profile-name> **accounting egress accounting-source** <*IFL* | **CLASS**>
set access aaa-profile <profile-name> **accounting egress byte-adjustment-factor** <0.00 - 2.00>
set access aaa-profile <profile-name> **accounting egress byte-adjustment-value** [-32 - 32]
set access aaa-profile <profile-name> **accounting egress class-byte-adjustment-factor** [0.00 - 2.00]
set access aaa-profile <profile-name> **accounting egress class-byte-adjustment-value** [-32 - 32]

The following command options allow you to set data usage accounting for outgoing traffic.

Attribute	Description
accounting-source	This option provides control over the counters used for egress session accounting when RADIUS accounting is enabled. The counters are the RADIUS attributes: Acct-Output-Packets (48), Acct-Output-Octets (43), and Acct-Output-Gigawords (53). By default, the class statistics (CLASS) are used, which represent the total traffic accepted across all queues. However, the egress control traffic is sent directly to the IFP and is, therefore, not included in the session class statistics. As a result, QoS is necessary for enabling the egress session accounting. As an alternative, the logical interface (IFL) statistics can be used to account for all transmitted traffic, excluding control traffic. However, this option may not be supported on all platforms. Default: CLASS, Supported options include: CLASS and IFL.
byte-adjustment-value	Adjust egress IFL counters by +/- N bytes per packet. That is, adjust egress IFL counters by adding or subtracting a specified number of bytes per packet. Default: 0.00, Range: -32 to 32.
byte-adjustment-factor	Adjust egress IFL counters by applying a specified factor. This adjustment is made after the byte-adjustment-value is applied. Default: 1.00, Range: 0.00 to 2.00.
class-byte-adjustment-value	Adjusts egress CLASS (queue) counters by adding or subtracting a specified number of bytes per packet (+/- N bytes per packet). Default: 0.00, Range: -32 to 32.
class-byte-adjustment-factor	Adjust egress CLASS (queue) counters by applying a specified factor. This adjustment is also made after the class-byte-adjustment-value is applied. Default: 1.00, Range: 0.00 to 2.00

RADIUS Profile Configuration

Subscriber management allows the configuration of a RADIUS profile, which is mandatory if RADIUS is used for authentication or accounting.

The diagram below illustrates how the RADIUS profile is associated with the subscriber management tasks at a broader level.

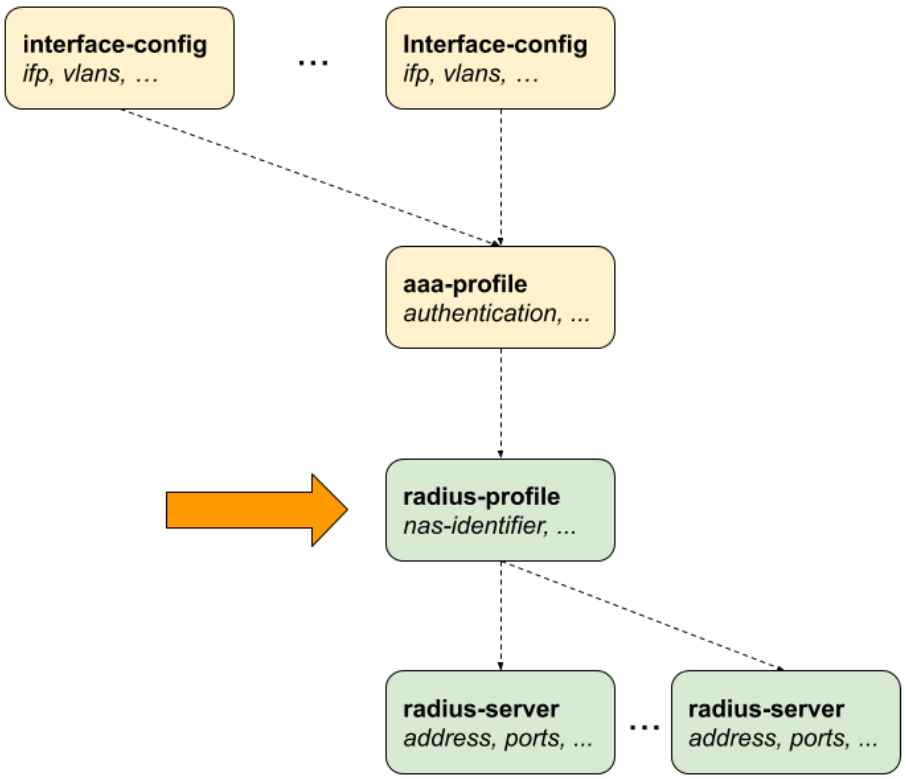


Figure 69. RADIUS Profile Configuration

Configuring the RADIUS Profile

The RADIUS profile configuration involves setting up various parameters that define how the router interacts with the RADIUS server for authentication, accounting, and so on.

set access radius-profile <profile-name> **accounting accounting-backup** [**false** | **true**]
set access radius-profile <profile-name> **accounting accounting-backup-max** [1 - 4294967295]
set access radius-profile <profile-name> **accounting accounting-on-off** [**false** | **true**]
set access radius-profile <profile-name> **accounting accounting-on-wait** [**false** | **true**]
set access radius-profile <profile-name> **accounting algorithm-type** [**DIRECT** | **ROUND-ROBIN**]
set access radius-profile <profile-name> **accounting radius-server-profile-name** <radius-server-profile-name>

set access radius-profile <profile-name> **accounting stop-on-reject** [**false** | **true**]
set access radius-profile <profile-name> **authentication algorithm-type** [**DIRECT** | **ROUND-ROBIN**]
set access radius-profile <profile-name> **authentication radius-server-profile-name** <radius-server-profile-name>
set access radius-profile <profile-name> **calling-station-id-format** [**NONE** | **MAC**]
set access radius-profile <profile-name> **nas-identifier** <nas-identifier>
set access radius-profile <profile-name> **nas-ip-address** <nas-ip-address>
set access radius-profile <profile-name> **nas-port-format** [**DEFAULT** | **SLOTS** | **PORTS**]
set access radius-profile <profile-name> **nas-port-type** [**Virtual** | **SDSL** | **ADSL-CAP** | **ADSL-DMT** | **Ethernet** | **xDSL** | **Cable** | **PPPoA** | **PPPoEoA** | **PPPoEoE** | **PPPoEoVLAN** | **PPPoEoQinQ** | **xPON**]

<table>
<tr><th>Attribute</th><th>Description</th></tr>
<tr><td>calling-station-id-format</td><td>Set the value for RADIUS attribute Calling-Station-Id (31). The default setting is NONE, meaning the attribute is not sent. If set to MAC, the client MAC address is sent as a string. Default: NONE.</td></tr>
<tr><td>nas-identifier</td><td>Set the value for the RADIUS attribute NAS-Identifier (32). Default: system hostname.</td></tr>
<tr><td>nas-ip-address</td><td>Set the value for RADIUS attribute NAS-IP-Address (4). Default: source IPv4 address.</td></tr>
<tr><td>nas-port-type</td><td>Set the value for RADIUS attribute NAS-Port-Type (61). Default: Ethernet.</td></tr>
<tr><td>nas-port-format</td><td>Set the format of the 32-bit RADIUS attribute NAS-Port (5).
<table>
<tr><th>Name</th><th>Bits</th><th>Values</th></tr>
<tr><td>DEFAULT</td><td>1:1:6:12:12</td><td>slot:subslot:port:vlan:vlan</td></tr>
<tr><td>SLOTS</td><td>6:2:6:12:6</td><td>slot:subslot:port:vlan:vlan</td></tr>
<tr><td>PORTS</td><td>0:1:7:12:12</td><td>slot:subslot:port:vlan:vlan</td></tr>
</table>
</td></tr>
</table>

To access the RESTCONF API that corresponds to this CLI, click here.

The following example shows a typical RADIUS profile for authentication and accounting. The RADIUS profile name is specified as 'radius-default'. NAS Identifier is set as BNG and NAS Port Type is specified as 'Ethernet'. RADIUS servers used for authentication is set 'radius-server-1' and 'radius-server-2'. RADIUS servers used for accounting is also set as 'radius-server-1' and 'radius-server-2'.

The Accounting RADIUS servers are specified as 'radius-server-1' 'radius-server-2'. For information about other options, see the table descriptions below.

```
supervisor@switch: cfg> show config access radius-profile radius-default
{
  "rtbrick-config:radius-profile": {
    "profile-name": "radius-default",
    "nas-identifier": "BNG",
    "nas-port-type": "Ethernet",
    "authentication": {
      "radius-server-profile-name": [
        "radius-server-1",
        "radius-server-2"
        ]
    },
    "accounting": {
      "radius-server-profile-name": [
        "radius-server-1",
        "radius-server-2"
        ],
      "stop-on-reject": "true",
      "stop-on-failure": "true",
      "accounting-on-off": "true",
      "accounting-on-wait": "true",
      "accounting-backup": "true",
      "accounting-backup-max": 86400
    }
  }
}
```

Configuring Authentication

The following configuration command and options set the 'radius-profile' as authentication method. It also defines the list of RADIUS servers and the algorithm for RADIUS high-availability.

Attribute	Description
-	Without any option, the command sets authentication for the RADIUS profile.
radius-server-profile-name	List of multiple RADIUS servers used for authentication.

Attribute	Description
algorithm-type	Specifies the authentication server selection algorithm. For more information, see RADIUS Redundancy. Default: DIRECT Values: DIRECT, ROUND-ROBIN

API To access the RESTCONF API that corresponds to this CLI, click here.

Configuring Accounting

Configuring accounting involves specifying its name and defining various parameters. The following command and options allow you to configure RADIUS accounting.

Attribute	Description
-	Without any option, the command sets accounting for the RADIUS profile.
radius-server-profile-name	List of RADIUS servers used for accounting.
algorithm-type	Specifies the accounting server selection algorithm. For more information, see RADIUS Redundancy. Default: DIRECT, Values: DIRECT and ROUND-ROBIN.
stop-on-failure	If set to true, the accounting will stop, if there is a failure in the process after authentication was accepted. Default: False.
stop-on-reject	If set to true, when the authentication is rejected, the accounting process will stop. Default: False.
accounting-on-off	Enables RADIUS Accounting-On/Off messages. For more information, see RADIUS Accounting. Default: False.
accounting-on-wait	Waits for an Accounting-On response ensuring that no new subscriber is allowed until the accounting process has been initiated. Default: False.
accounting-backup	Enables backup for accounting (optional). RADIUS accounting requests are often used for billing and, therefore should be able to store and retry over a longer period (commonly, up to 24 hours or more). Default: False.

Attribute	Description
accounting-backup-max	If enabled, this option defines maximum backup accounting hold time, in seconds. Default: 3600, Range: 1 - 4294967295.

API To access the RESTCONF API that corresponds to this CLI, click here.

RADIUS Server Configuration

Subscriber Management often relies on the RADIUS server for authentication, authorization, and accounting. There are alternative AAA solutions, including local methods that operate independently of network availability.

The RADIUS server configuration is not standalone; it is inherently dependent on the configuration of a RADIUS profile. You must first create a RADIUS profile before configuring the associated RADIUS server.

The following diagram illustrates how RADIUS server configuration fits into the broader context of subscriber management tasks.

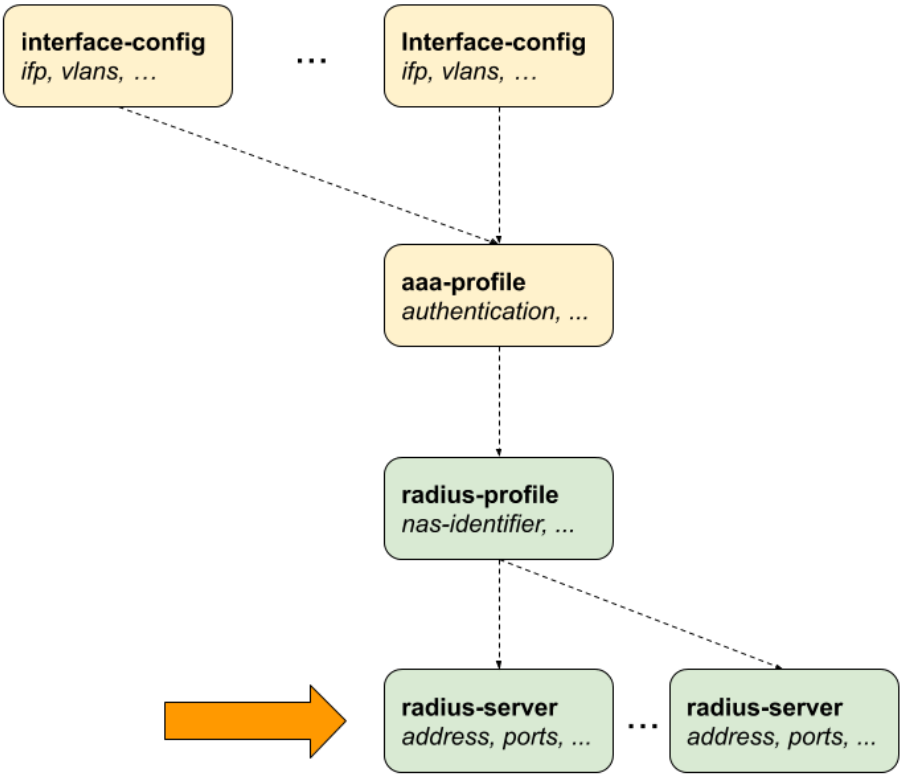


Figure 70. RADIUS Server Configuration

Configuring the RADIUS Server

The following configuration command and options are used to configure a RADIUS server.

set access radius-server <server-name> **address** <address>
set access radius-server <server-name> **authentication enable** [**false** | **true**]
set access radius-server <server-name> **authentication outstanding** [1 - 65535]
set access radius-server <server-name> **authentication port** [1 - 65535]
set access radius-server <server-name> **authentication retry** [1 - 255]
set access radius-server <server-name> **authentication timeout** [1 - 65535]
set access radius-server <server-name> **coa enable** [**false** | **true**]
set access radius-server <server-name> **coa port** [1 - 65535]
set access radius-server <server-name> **rate** [1 - 65535]
set access radius-server <server-name> **routing-instance** <routing-instance>
set access radius-server <server-name> **secret-encrypted-text** <secret-encrypted-text>
set access radius-server <server-name> **secret-plain-text** <secret-plain-text>
set access radius-server <server-name> **source-address** <source-address>

Attribute	Description
<server-name>	Specifies the name used to identify the RADIUS server within the system.
accounting	Enables and configures RADIUS accounting, allowing the system to send session usage and lifecycle information (start, stop, interim updates) to the server.
address	Defines the IP address or hostname of the RADIUS server to which authentication and accounting requests are sent. NOTE: Multiple RADIUS servers with the same IPv4 address are not supported, even if the instance or port is different.
authentication	Enables and configures RADIUS-based authentication for validating subscriber or user credentials.

Attribute	Description
coa	Enables support for Change of Authorization (CoA), allowing the RADIUS server to dynamically modify session parameters after authentication.
rate	Specifies the maximum number of RADIUS requests that can be sent to the server per second, used to control traffic and prevent server overload. Default: 600. Range: 1 - 65535.
routing-instance	Associates the RADIUS server communication with a specific routing instance (VRF), enabling reachability in multi-VRF deployments.
secret-encrypted-text	Configures the shared secret key in encrypted form for secure communication between the device and the RADIUS server.
secret-plain-text	Configures the shared secret key in plain text format; typically used for initial setup before encryption is applied.
source-address	Specifies the source IPv4 address used for outgoing RADIUS packets, ensuring consistent identification and proper routing.

API To access the RESTCONF API that corresponds to this CLI, click here.

The following example shows the RADIUS server configuration for authentication and accounting. Each of these options allows you to define how the RADIUS server will operate. The command sets RADIUS server name as 'radius-server-1'. The configuration specifies the IP address '198.51.100.101' of the RADIUS server, which the router will use to send RADIUS requests. The source IP address is specified as '198.51.100.200'. It sets 'CoA' (Change-of-Authorization), a feature that allows the RADIUS server to change the authorization parameters of a session after it has been established.

The secret-encrypted-text parameter is specified that configures the RADIUS secret in an encrypted format. The key is used for encrypting RADIUS messages between the client and server to ensure security.

```
supervisor@switch: cfg> show config access radius-server radius-server-1
{
  "rtbrick-config:radius-server": {
    "server-name": "radius-server-1",
    "address": "198.51.100.101",
```

```
    "source-address": "198.51.100.200",
    "secret-encrypted-text": "$21e4946e31b406de98b3077aef03ed5a7",
    "authentication": {
      "enable": "true"
    },
    "accounting": {
      "enable": "true"
    },
    "coa": {
      "enable": "true"
    }
  }
}
```

Configuring Authentication

The following command and options allow to configure the authentication settings on a RADIUS server. The enable option is used to activate RADIUS authentication for the specified RADIUS server 'radius-server-1'. The outstanding option allows you to specify the maximum number of pending authentication requests that the device can have at any given time. The port option enables you to define the port number used for RADIUS authentication requests. The retry option defines the maximum number of retries the device makes if the RADIUS server does not acknowledge an authentication request. This ensures that transient network issues do not cause authentication failures. The timeout setting determines the time, in seconds, that the device will wait for a response from the RADIUS server after sending authentication requests. If the server does not respond within this time frame, the request will be considered timed out.

set access radius-server <server-name> **authentication enable** [**false** | **true**]
set access radius-server <server-name> **authentication outstanding** [1 - 65535]
set access radius-server <server-name> **authentication port** [1 - 65535]
set access radius-server <server-name> **authentication retry** [1 - 255]
set access radius-server <server-name> **authentication timeout** [1 - 65535]

Attribute	Description
-	Without any option, the command sets RADIUS server authentication.

Attribute	Description
enable	Enables RADIUS authentication. Default: False.
port	RADIUS authentication port. Default: 1812. Range: 1 - 65535.
retry	This option specifies the number of authentication retries before declaring this server as unreachable for authentication. After reaching the limit, the client begins to send requests to other RADIUS servers and rejects the request after receiving the end of the list. Default: 3. Range: 1 - 255.
timeout	Authentication request timeout, in seconds. Default: 5. Range: 1 - 65535.
outstanding	This option specifies the maximum number of outstanding authentication requests for this RADIUS server. A request is counted as outstanding if sent out but the response is not received. Default: 100. Range: 1 - 65535.

API To access the RESTCONF API that corresponds to this CLI, click here.

Configuring Accounting

RADIUS accounting allows the tracking of user sessions. This configuration sets up RADIUS accounting on a specified RADIUS server. When enabled, the device will send accounting data to the RADIUS server.

Syntax:

set access radius-server <server-name> **accounting enable** [**false** | **true**]
set access radius-server <server-name> **accounting outstanding** [1 - 65535]
set access radius-server <server-name> **accounting port** [1 - 65535]
set access radius-server <server-name> **accounting retry** [1 - 255]
set access radius-server <server-name> **accounting timeout** [1 - 65535]

Attribute	Description
enable	Enable RADIUS accounting. Default: False.

Attribute	Description
port	This specifies the port number on the RADIUS server that is used for accounting purpose. Default: 1813. Range: 1 - 65535.
retry	This option determines the maximum number of attempts the device will make to send an accounting request to the RADIUS server before marking the server as unreachable for accounting. Once the retry limit is reached, the device will attempt to send accounting requests to other configured RADIUS servers. Default: 10. Range: 1 - 255.
timeout	Accounting request timeout, in seconds. Default: 30. Range: 1 - 65535.
outstanding	This option specifies the maximum number of outstanding accounting requests for this RADIUS server. A request is counted as outstanding if sent out, but the response is not received. Default: 100. Range: 1 - 65535.

API To access the RESTCONF API that corresponds to this CLI, click here.

Configuring Change-of-Authorization (CoA)

Change-of-Authorization (CoA) allows a RADIUS server to send requests to the network device to change the authorization parameters of an active session. The following configuration involves setting up CoA for a specified RADIUS server called 'radius-server-1'.

Syntax:

```
set access radius-server <server-name> coa enable
set access radius-server <server-name> coa port [1 - 65535]
```

Attribute	Description
enable	This option enables the device to receive CoA requests from the specified RADIUS server. Default: False.

Attribute	Description
port	Specifies the device port that listens/receives for CoA requests from the RADIUS server. Default: 3799. Range: 1 - 65535.

API To access the RESTCONF API that corresponds to this CLI, click here.

Service Profile Configuration

You can set up Service Profile to assign specific Quality of Service (QoS) and IGMP settings to individual subscribers. This ensures that each subscriber gets the right level of service based on their requirements.

The Service Profile configuration is optional.

The following diagram illustrates how the service profile is associated with other subscriber management tasks.

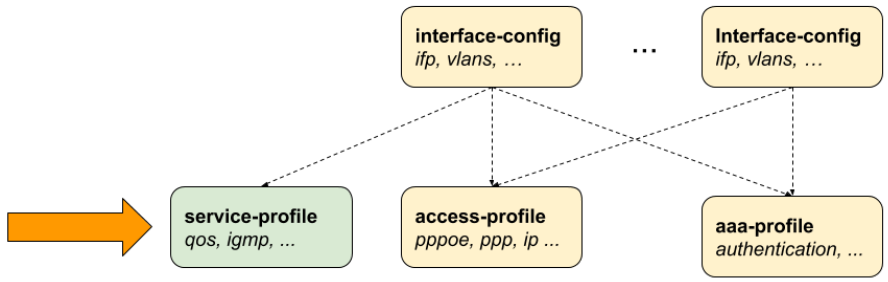


Figure 71. Service Profile Configuration

Configuring the Service Profile

The following command and options are used to set up a service profile named 'iptv'.

set access service-profile <profile-name> **acl**
set access service-profile <profile-name> **address-translation**
set access service-profile <profile-name> **http-redirect**
set access service-profile <profile-name> **igmp**
set access service-profile <profile-name> **qos**

Attribute	Description
-	Without any option, the command creates the specified service profile.
<profile-name>	Specifies the name of the service profile.
acl	Configures ACL-related attributes for the service profile.
address-translation	Configures CGNAT-related attributes for the service profile.
http-redirect	Configures HTTP redirect-related attributes for the service profile.
igmp	Configures IGMP-related attributes for the service profile.
qos	Configures QoS-related attributes for the service profile.

The following example shows a service profile configuration for subscribers with IPTV (multicast) services. The configuration defines specific QoS and IGMP settings that will be applied to subscribers using this service profile. In this configuration, the service profile named ‘iptv’ is linked to a QoS profile named ‘iptv-qos-xl’. This QoS profile defines the prioritization and bandwidth allocation for IPTV traffic for the subscriber profile that it is associated with.

Additionally, the configuration specifies the IGMP settings. Enabling IGMP is achieved by setting it to 'true' for the service profile that enables subscribers to join multicast groups. The configuration specifies the IGMP profile named 'iptv-basic', with IGMP version 3 in use. The parameter max-members is set to 10, which limits the number of simultaneous multicast groups (maximum IGMP memberships) that a subscriber can join.

```
supervisor@switch: cfg> show config access service-profile iptv
{
  "rtbrick-config:service-profile": {
    "profile-name": "iptv",
    "qos": {
      "profile": "iptv-qos-xl"
    },
    "igmp": {
      "enable": "true",
      "profile": "iptv-basic",
      "version": "IGMPv3",
      "max-members": 10
    }
  }
}
```

API To access the RESTCONF API that corresponds to this CLI, click here.

Configuring QoS

The following QoS configuration defines the QoS settings for the service profile 'iptv'.

Attribute	Description
parent-scheduler	This option defines the parent scheduler element within the scheduler-map that is assigned to the subscriber. If the parent scheduler is not specified, the scheduler-map will be directly bound to the local IFP where the session is established. This attribute can only be set once and cannot be changed without disconnecting the session. The parent scheduler can also be configured through RADIUS, which gets priority over the local configuration.  Assigning a QoS parent scheduler that does not exist on the corresponding IFP will result in blackholing all egress data traffic. Control traffic will remain unaffected, allowing the session to persist despite the data loss.
profile	This option assigns a specific QoS configuration profile to the subscriber. The QoS profile can be also set through RADIUS. If configured both locally and through RADIUS, the RADIUS setting gets priority.

 To access the RESTCONF API that corresponds to this CLI, click here.

Configuring IGMP

This configuration sets IGMP options in the service profile to provide multicast IPTV to subscribers. It lets you control IGMP features like turning the service on, limiting group memberships per subscriber, linking an IGMP profile, and choosing the protocol version. These settings help ensure efficient multicast, scalability, and support for different client types.

The following IGMP configuration defines the settings for the service profile 'iptv'.

set access service-profile <profile-name> **igmp enable** [**false** | **true**]
set access service-profile <profile-name> **igmp max-members** <max-members>
set access service-profile <profile-name> **igmp profile** <profile>
set access service-profile <profile-name> **igmp version** [**IGMPv1** | **IGMPv2** | **IGMPv3**]

Attribute	Description
enable	This option dynamically enables or disables IGMP for a subscriber. Default: False.
max-members	This option limits the number of simultaneous multicast channels (maximum IGMP memberships) a subscriber can join. Default: 1. Range: 1 - 4294967295.
profile	This option specifies the IGMP profile to be associated with the subscriber.
version	This defines the version of IGMP for a subscriber. Default: V3. Values: V1, V2, and V3.

API To access the RESTCONF API that corresponds to this CLI, click here.

L2TP Profile Configuration

The L2TPv2 profile specifies the parameters needed to establish and manage L2TP tunnels between the access node (LAC) and the L2TP Network Server (LNS). Through this profile, you can control key attributes such as tunnel endpoints, authentication methods, and session management.

Configuring an L2TP profile is optional in subscriber management and is only required when L2TP-based tunneling is used for subscriber sessions. If L2TP is not part of the deployment, subscriber sessions can be handled without this profile.

The following diagram illustrates how the L2TP profile configuration is are associated with the other Subscriber Management tasks.

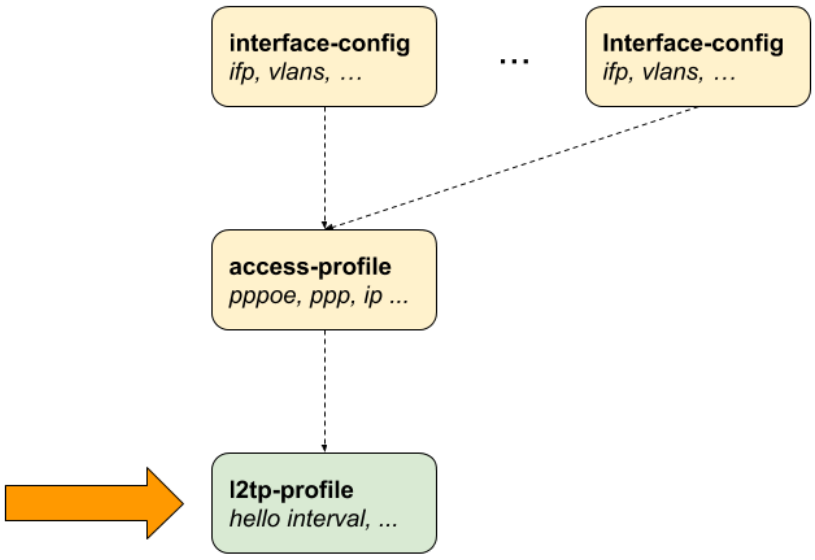


Figure 72. L2TPv2 Profile Configuration

Configuring the L2TP Profile

The following command and options allow you to configure an L2TP profile.

Syntax:

set access l2tp-profile <profile-name> **client-ipv4** <client-ipv4>
set access l2tp-profile <profile-name> **client-name** <client-name>
set access l2tp-profile <profile-name> **connect-speed-update** [**false** | **true**]
set access l2tp-profile <profile-name> **dead-timeout-interval** [1 - 4294966]
set access l2tp-profile <profile-name> **hello-interval** [0 - 86400]
set access l2tp-profile <profile-name> **hide-authentication** [**false** | **true**]
set access l2tp-profile <profile-name> **idle-timeout-interval** [0 - 4294966]
set access l2tp-profile <profile-name> **inactive-timeout-interval** [1 - 4294966]
set access l2tp-profile <profile-name> **instance** <instance>
set access l2tp-profile <profile-name> **pon-access-line-version** [**DISABLED** | **DRAFT-LIHAWI-00** | **DRAFT-LIHAWI-04**]
set access l2tp-profile <profile-name> **pool-name** <pool-name>
set access l2tp-profile <profile-name> **receive-window** [1 - 256]
set access l2tp-profile <profile-name> **request-retries** [1 - 600]
set access l2tp-profile <profile-name> **request-timeout-interval** [1 - 30]

set access l2tp-profile <profile-name> **retransmit-interval** [1 - 30]
set access l2tp-profile <profile-name> **selection-algorithm** [**BALANCED** | **RANDOM**]
set access l2tp-profile <profile-name> **service-label** <service-label>
set access l2tp-profile <profile-name> **session-limit** [1 - 65535]

Attribute	Description
client-ipv4	This is the default IPv4 address for the local L2TP tunnel client (LAC), if no specific address is provided through the L2TP pool or RADIUS configuration.
client-name	This is the default hostname for the local L2TP tunnel client (LAC) if no specific hostname is provided through the L2TP pool or RADIUS configuration. Default: system hostname.
instance	The routing instance in which the L2TP endpoint (LNS) is reachable. Default: Default.
service-label	Define the service label to support L2TP over MPLS. For more details, see Configuring L2TP over MPLS. For details on the supported label ranges, see the undefined/techdocs/current/platform/resource_limit.html#static-system-dynamic-label-ranges[Static, System, and Dynamic Label Ranges] section in the Platform Guide.
selection-algorithm	It defines how to select a tunnel from a pool of available LNS servers. For more information, see L2TP Tunnel Selection. The RANDOM algorithm selects a tunnel randomly, while the BALANCED algorithm chooses the tunnel with the fewest sessions. Default: BALANCED, Supported values: BALANCED and RANDOM.
session-limit	This is the default session limit for a tunnel unless otherwise specified. Tunnels that have reached their session limit are not considered for additional sessions. Default: 64000, Range: 1 - 65535.

Attribute	Description
pool-name	This allows to assign a default L2TP tunnel pool. For more information, see L2TP Tunnel Pool Configuration. This default can be overwritten by user-defined pool names from the local user profiles (For more information, see User Profile Configuration) or received through RADIUS attribute RtBrick-L2TP-Pool (VSA 26-50058-40).
hello-interval	Specifies the L2TP tunnel hello interval time, in seconds. '0' indicates disabled. The HELLO keep-alive messages are part of the L2TP control channel. For more information, see L2TP Control Channel. These messages are sent only when the message queue is empty, and no other messages have been transmitted during the hello interval. Default: 30, Range: 0 - 86400.
idle-timeout-interval	This interval defines the maximum time, in seconds, to keep a tunnel without sessions established. The session will remain forever if this value is set to 0. Default: 600, Range: 0 - 4294966.
dead-timeout-interval	This interval defines the time, in seconds, This interval defines the time, in seconds, that a tunnel remains in the DEAD state if it becomes unreachable. Once the interval expires, the tunnel transitions back to the DOWN state, making it available for new sessions. Default: 300, Range: 1 - 4294966.
inactive-timeout-interval	This interval defines the time, in seconds, to keep an inactive tunnel before removal. This interval is reset with every new session request which considers this tunnel as a potential candidate. Default: 900, Range: 1 - 4294966.

Attribute	Description
receive-window	Specifies the receive window size offered to the remote peer trough the Receive Window Size AVP (10) in SCCRQ or SCCRP message. For example, if a receive window size of '8' is advertised in the SCCRQ or SCCRP message, the remote peer can send up to 8 unacknowledged control messages. After reaching this limit, it must wait for an acknowledgment to advance the window before sending additional messages. Default:* 8, Range: 1 - 256.
request-retries	Defines the number of times the system attempts to establish a tunnel before considering it unsuccessful. See also the`request-timeout-interval` attribute. Default: 5, Range: 1 - 600.
request-timeout-interval	This interval, when multiplied by the number of request retries, determines the maximum time (in seconds) to wait for the selected tunnel to establish before selecting to another tunnel from the list. Default: 1, Range: 1 - 30.  Modify the values for request-retries and request-timeout-interval attributes with caution, as incorrect value may lead to delay in tunnel establishment.
retransmit-interval	This value specifies the interval, in seconds, between retransmissions of a message. Each successive retransmission uses an exponential backoff interval, meaning the interval doubles after each retransmission. For example, if the first retransmission occurs after 1 second, the next will occur after 2 seconds, then 4 seconds, 8 seconds, 16 seconds, 32 seconds, and finally 64 seconds. After a maximum of 6 retransmissions, the interval reaches its maximum value. For a retransmit interval of 1, the total time can reach 64 seconds, and for an interval of 2, it can extend up to 128 seconds and so on. Default: 1, Range: 1 - 30.

Attribute	Description
hide-authentication	When enabled, the L2TP proxy will hide the authentication response AVP if the authentication type is PAP, ensuring that the password is not transmitted in plain text. Default: False.
pon-access-line-version	Adding additional PON attributes to the L2TP access line information. (For more information, see L2TP Access Line Information (RFC5515)) as defined in draft-lihawi-ancp-protocol-access-extension which can be optionally enabled using this configuration attribute. RFC and draft compliance are partial except as specified. The value DRAFT-LIHAWI-00 enables PON attributes based on the definition in draft-lihawi-ancp-protocol-access-extension-00 whereas DRAFT-LIHAWI-04 uses draft-lihawi-ancp-protocol-access-extension-04. **Default** DISABLED, Values: DRAFT-LIHAWI-00, DRAFT-LIHAWI-04
connect-speed-update	Enable L2TP Connect-Speed-Update-Notification (CSUN) requests as defined in RFC5515. For more information, see Connect-Speed-Update-Notification (CSUN). CSUN is an L2TP control message sent by the LAC to the LNS to provide updates on transmit and receive connection speeds for one or more sessions. By default, this feature is disabled but can be enabled using this configuration. Default: False.

API To access the RESTCONF API that corresponds to this CLI, click here.

The following example shows a typical L2TPv2 LAC configuration profile. It outlines a typical L2TPv2 LAC profile, defining essential parameters such as session limits, heartbeat intervals, client identification, and security settings.

This configuration example defines an L2TPv2 LAC (L2TP Access Concentrator) profile named 'l2tp-default'. The profile-name is set 'l2tp-default'. This session-limit parameter sets the maximum number of sessions that can be established within

this L2TP tunnel. The value '4000' indicates that up to 4000 sessions are allowed. The hello-interval is set to '60' which indicates the interval (in seconds) for sending 'hello' messages to check the status of the L2TP tunnel.

The client-name is specified as 'BNG', which is the name of the client of the L2TP tunnel. The client-ipv4 is set to '198.51.100.200' which is the 'BNG' IP address. The hide-authentication parameter determines whether the authentication credentials for the L2TP tunnel should be hidden. Setting it to true indicates the credentials are hidden.

The parameter service-label is set to '1234'. It assigns an MPLS service label to the L2TP tunnel. The value '1234' is used as the service label for this tunnel.

```
supervisor@switch: cfg> show config access l2tp-profile l2tp-default
{
  "rtbrick-config:l2tp-profile": {
    "profile-name": "l2tp-default",
    "session-limit": 4000,
    "hello-interval": 60,
    "client-name": "BNG",
    "client-ipv4": "198.51.100.200",
    "hide-authentication": true
    "service-label": 1234
  }
}
```

Configuring L2TP over MPLS

L2TP over MPLS requires a dedicated L2TP service label which must be defined manually. First, you must assign a specific MPLS label for L2TP services. This is done in the L2TP profile configuration. Next, you must configure BGP to advertise this label. This involves configuring a routing policy that specifies how to handle the L2TP service label in BGP updates.

Following is an example command for L2TP configuration with L2TP service label.

```
set access l2tp-profile l2tp-default service-label 1234
```

Advertising this label through BGP must be configured manually as shown in the following example. The exact policy configuration depends on the actual network and existing policy concept.

In the following configuration, the policy named L2TP_MPLS contains rules for traffic related to L2TP over MPLS. The policy consists of multiple rules, each

specifying conditions for matching traffic and actions to take.

In the 'Ordinal 1' match rule, it specifies the Type as 'ipv4-prefix', Value-Type as 'discrete', Match-Type as 'exact' and Value is set to '198.51.100.200/24'. This rule matches traffic that has an exact IPv4 prefix of 198.51.100.200/24.

In the Action Rule, it specifies Type as 'label', Operation as 'overwrite' and Value: label is set to '1337,bos:1'. If the traffic matches the IPv4 prefix, the action overwrites the MPLS label with '1337' and sets the BOS bit to '1'.

In the 'Ordinal 2', it defines the action rule. After applying the label overwrite action in 'Ordinal 1', this rule permits the traffic to continue through the network with the updated label.

```
supervisor@switch: cfg> show config policy
{
    "rtbrick-config:policy": {
      "statement": [
        {
          "name": "L2TP_MPLS",
          "ordinal": [
            {
              "ordinal": 1,
              "match": {
                "rule": [
                  {
                    "rule": 1,
                    "type": "ipv4-prefix",
                    "value-type": "discrete",
                    "match-type": "exact",
                    "value": "198.51.100.200/24"
                  }
                ]
              },
              "action": {
                "rule": [
                  {
                    "rule": 1,
                    "type": "label",
                    "operation": "overwrite",
                    "value": "label:1337,bos:1"
                  }
                ]
              }
            },
            {
              "ordinal": 2,
              "action": {
                "rule": [
                  {
                    "rule": 1,
                    "operation": "return-permit"
                  }
                ]
```

```
            }
          }
        ]
      }
    ]
  }
}
```

In the following configuration, the instance name is set as 'internet' and the Address Family is specified as 'ipv4 and unicast'. The export policy is set to L2TP_MPLS, indicating that the label defined in the L2TP_MPLS policy will be advertised for this instance.

```
supervisor@switch: cfg> show config instance internet
{
  "rtbrick-config:instance": {
    "name": "internet",
    "address-family": [
      {
        "afi": "ipv4",
        "safi": "unicast",
        "policy": {
          "export": "L2TP_MPLS"
        }
      }
    ]
  }
}
```

Configuring L2TP LCP Classification

RBFS supports L2TP LCP (Link Control Protocol) classification. It allows the system to identify LCP packets within an L2TP tunnel and handle them differently by tagging LCP control packets for special processing.

The feature allows for the prioritization of LCP Echo-Request and Echo-Reply messages which ensure stable L2TP sessions. The L2TP LCP Classification support only downstream traffic, that is traffic traversing from the LNS (L2TP Network Server) to the subscriber.



L2TP LCP classification is supported only on Q2C-based platforms.

Syntax:

set forwarding-options acl l3v4 rule <rule-name> **ordinal** <number> **match direction** [**ingress** | **egress**]

set forwarding-options acl l3v4 rule <rule-name> **ordinal** <number> **match l2tp-ppp-lcp true**
set forwarding-options acl l3v4 rule <rule-name> **ordinal** <number> **match destination-ipv4-prefix** <destination-ipv4-prefix>
set forwarding-options acl l3v4 rule <rule-name> **ordinal** <number> **action forward-class** [**class-0** | **class-1** | **class-2** | **class-3** | **class-4** | **class-5** | **class-6** | **class-7** | **class-all**]
set forwarding-options acl l3v4 rule <rule-name> **ordinal** <number> **priority** <value>

Options	Description
<number>	Specifies the ordinal number.
match direction	Traffic direction. Only ingress is supported.
l2tp-ppp-lcp [true / false]	Specify 'true' to classify the LCP control packets.
action forward-class	Specify the forward class for action.
priority	Prioritize this ACL rule against others.

Example:

The following ACL configuration for LCP control plane packets matches all incoming IPv4 packets and assign them to forwarding class class-4 for further differentiated treatment.

```
set forwarding-options acl l3v4 rule l2tp_match_lcp
set forwarding-options acl l3v4 rule l2tp_match_lcp ordinal 1
set forwarding-options acl l3v4 rule l2tp_match_lcp ordinal 1 match direction
ingress
set forwarding-options acl l3v4 rule l2tp_match_lcp ordinal 1 match l2tp-ppp-lcp
true
set forwarding-options acl l3v4 rule l2tp_match_lcp ordinal 1 match destination-
ipv4-prefix 131.0.0.1/32
set forwarding-options acl l3v4 rule l2tp_match_lcp ordinal 1 action forward-class
class-4
set forwarding-options acl l3v4 rule l2tp_match_lcp ordinal 1 priority 100
```

```
"rtbrick-config:acl": {
    "l3v4": {
      "rule": [
        {
          "rule-name": "l2tp_match_lcp",
          "ordinal": [
            {
              "ordinal-value": 1,
```

```
              "match": {
                "destination-ipv4-prefix": "131.0.0.1/32",
                "direction": "ingress",
                "l2tp-ppp-lcp": "true"
              },
              "action": {
                "forward-class": "class-4"
              },
              "priority": 100
            }
          ]
        }
      ]
    }
  }
}
```

L2TP Tunnel Pool Configuration

The configuration of the Layer 2 Tunnel Protocol (L2TPv2) pool is optional for subscriber management. It is necessary only if you want to enable L2TP tunneling.

The L2TP pool configuration helps to efficiently organize and manage multiple LNS servers. It allows you to define these sets locally to ensure that L2TP tunnels are directed to the appropriate servers.

Syntax:

set access l2tp-pool <pool-name> <client-name> <server-name> **client-ipv4** <client-ipv4>
set access l2tp-pool <pool-name> <client-name> <server-name> **preference** [0 - 65535]
set access l2tp-pool <pool-name> <client-name> <server-name> **secret-encrypted-text** <secret-encrypted-text>
set access l2tp-pool <pool-name> <client-name> <server-name> **secret-plain-text** <secret-plain-text>
set access l2tp-pool <pool-name> <client-name> <server-name> **server-ipv4** <server-ipv4>
set access l2tp-pool <pool-name> <client-name> <server-name> **session-limit** [1 - 65535]

Configuring the L2TP Tunnel Pool

The following command and options allow you to configure an L2TP tunnel pool.

Attribute	Description
<pool-name>	Specifies the name of the L2TP pool, which groups L2TP client-server mappings for tunnel establishment.
<client-name>	Specifies the local L2TP tunnel client (LAC) hostname, representing the client initiating L2TP tunnels.
<server-name>	Specifies the remote L2TP tunnel server (LNS) hostname, which terminates L2TP tunnels and provides subscriber services.
client-ipv4	Specifies the IPv4 address of the local L2TP tunnel client (LAC) IPv4 address used for establishing the tunnel.
server-ipv4	Specifies the remote L2TP tunnel server (LNS) IPv4 address to which tunnels are established.
preference	Defines the priority of the LNS within the pool. Lower values indicate higher preference when selecting a server. Default: 0, Range: 1 - 65535.
session-limit	Tunnels with a session limit reached are not considered for further sessions. This limit has precedence over the default session limit specified in the l2tp-profile. Default: 64000, Range: 1 - 65535.
secret-encrypted-text	Configures the shared secret in encrypted form for secure authentication between the LAC and LNS.
secret-plain-text	Configures the shared secret in plain text format. L2TP tunnel secret can be provided as plaintext or an already encrypted text.

The following example shows a local pool with two LNS severs.

This configuration sets an L2TP pool named 'lns-pool-example' with two LNS servers (LNS1 and LNS2). It defines how the device will manage L2TP tunnels. In this example, there are two different LNS server entries for two different LNS servers, LNS1 and LNS2. Both entries belong to the same pool named 'lns-pool-example'. Each entry in the l2tp-pool array defines the configuration for an individual LNS server.

The client-name is specified as BNG, which indicates that the client will initiate L2TP tunnels to the listed LNS servers. The server-name specifies the name of the

LNS. Each entry has a unique server name, LNS1 for the first entry and LNS2 for the second.

The client-ipv4 specifies the IPv4 address of the L2TP client, that is BNG. In both entries, the LAC's IP address is '198.51.100.200'. The server-ipv4 specifies the IPv4 address of the LNS. The first entry has '198.51.100.219' for LNS1, and the second entry has '198.51.100.220' for LNS2.

The secret-encrypted-text parameter specifies the shared secret used for authenticating the L2TP tunnel between the LAC and LNS. The value is encrypted, and the secret is the same in both entries: '$21e4946e31b406de98b3077aef03ed5a7'.

The preference parameter sets the preference value for the LNS server. A lower value generally indicates a higher preference, but in this case, both entries have the same preference value of 1000. The session-limit parameter specifies the maximum number of sessions (L2TP tunnels) that can be established with the LNS server. Both entries have a session limit of 1000.

```
supervisor@switch: cfg> show config access
{
  "rtbrick-config:access": {
    "l2tp-pool": [
      {
        "pool-name": "lns-pool-example",
        "client-name": "BNG",
        "server-name": "LNS1",
        "client-ipv4": "198.51.100.200",
        "server-ipv4": "198.51.100.219",
        "secret-encrypted-text": "$21e4946e31b406de98b3077aef03ed5a7",
        "preference": 1000,
        "session-limit": 1000
      },
      {
        "pool-name": "lns-pool-example",
        "client-name": "BNG",
        "server-name": "LNS2",
        "client-ipv4": "198.51.100.200",
        "server-ipv4": "198.51.100.220",
        "secret-encrypted-text": "$21e4946e31b406de98b3077aef03ed5a7",
        "preference": 1000,
        "session-limit": 1000
      }
    ]
  }
}
```

API To access the RESTCONF API that corresponds to this CLI, click here.

User Profile Configuration

This section describes how to configure locally defined user profiles for subscriber authentication. While external servers such as RADIUS are typically used, the system also supports local authentication using these profiles. User profiles allow you to define credentials and session parameters directly on the device. This provides an alternative authentication method, especially useful in small deployments or testing scenarios.

Configuring User Profile

Syntax:

set access user-profile <user-name> **l2tp-pool-name** <l2tp-pool-name>
set access user-profile <user-name> **password-encrypted-text** <password-encrypted-text>
set access user-profile <user-name> **password-plain-text** <password-plain-text>
set access user-profile <user-name> **tunnel-type** [**PPPoE** | **L2TP**]

The following command and options are used to configure a user profile. A user profile also includes authentication details.

Attribute	Description
-	Without any option, the command sets a user profile.
user-name	Specifies the username for which the user profile is configured.
l2tp-pool-name	Associates an L2TP pool used for assigning tunnel endpoints to the user.
password-encrypted-text	Specifies the user password in encrypted form for secure authentication.
password-plain-text	Specifies the user password in plain text, which is internally encrypted before storage.
tunnel-type	Specifies the tunnel type used for the subscriber session (for example, L2TP). Default: PPPoE. Values: PPPoE or L2TP.

The following configuration shows the user name specified as 'user@rtbrick.com'.

The password-encrypted-text attribute enables you to set the user's password in an encrypted format. The tunnel-type is set to PPPoE.

```
supervisor@switch: cfg> show config access user-profile user@rtbrick.com
{
  "rtbrick-config:user-profile": {
    "user-name": "user@rtbrick.com",
    "password-encrypted-text": "$243a1341f44f54888cdd385b9f40513f1",
    "tunnel-type": "PPPoE"
  }
}
```

API To access the RESTCONF API that corresponds to this CLI, click here.

IP Address Pool Configuration

IP address pools are crucial for assigning IP addresses to subscribers, and configuring these pools is an essential for subscriber management.

The following image illustrates the IP address pool configuration and how they are associated with the other subscriber management tasks.

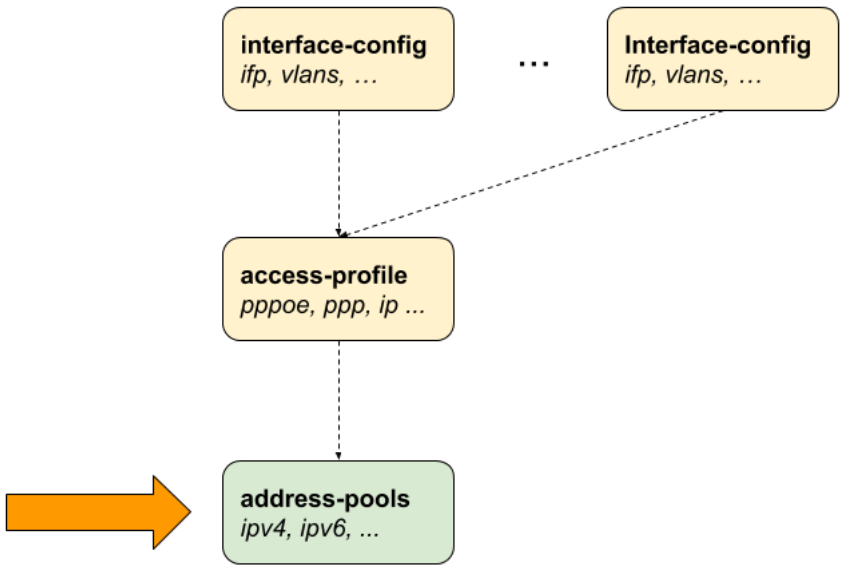


Figure 73. IP Address Pool Configuration

RBFS IP Address Pool

RBFS allows you to manage address pools with more flexibility. It enables you to modify or remove pools without disrupting active subscriber sessions. If an address pool is deleted, subscribers who have already been assigned IP addresses from that pool can continue using those addresses until their session ends. The

system does not immediately revoke the IP addresses assigned to active sessions.

Imagine a subscriber has been allocated an IP address from a specific address pool. If that pool is later deleted, the subscriber's connection remains unaffected until their session ends.

It displays an error message when a pool that is part of a pool chain is deleted, or when a non-existent pool is attached to an access profile. It ensures configuration consistency when 'next-pool-name' is not defined or invalid.

The following is an example of a generated error message.

```
Jan 16 04:28:37: Commit failed. Edit and try again or discard changes: application
operation-failed IPv6 pool referenced in access-profile does not exist
```



Ensure that the deleted address pool is not reallocated elsewhere until all assigned addresses are no longer in use. This prevents IP address conflicts.

Duplicate Address Detection

RBFS provides an optional duplicate address detection feature that prevents a new session from using an IP address already in use by another active session. This is to avoid conflicts. However, when an address pool is moved to a different BNG, the duplicate address detection feature may not work as expected.



Migrating address pools across different BNGs could lead to address conflicts, if not managed carefully.

Configuring the Address Pool

The following command and options allows you to configure both IPv4 and IPv6 address pools for subscriber access.

set access pool <pool-name> **ipv4-address**
set access pool <pool-name> **ipv6-prefix**
set access pool <pool-name> **next-pool-name** <next-pool-name>

Attribute	Description
<pool-name>	Specifies the unique name used to identify the address pool.
ipv4-address	Configures the IPv4 address range and related parameters for assigning IPv4 addresses to subscribers.
ipv6-prefix	Configures the IPv6 prefix pool used for delegating IPv6 prefixes to subscribers.
next-pool-name	Specifies an alternate address pool to be used when the current pool is exhausted, enabling hierarchical or fallback allocation.

The following example shows typical IPv4 address and IPv6 prefix pools. It shows three pools: one for IPv4 addresses and two for IPv6 prefixes. Each pool is defined by a name, and a range of addresses or prefixes is specified using the 'low' and 'high' values. These pools are used for dynamically assigning IP addresses or prefixes to devices or subscribers, depending on the protocol (IPv4 or IPv6).

The IPv4 address pool, named 'ipv4-local', includes the address range from ‘198.51.100.76’ to ‘198.51.100.117’. This pool defines a range of IPv4 addresses from 198.51.100.76 to 198.51.100.117. These addresses can be dynamically assigned to devices or subscribers that require IPv4 connectivity.

The specified second pool is ‘ipv6-local’ that defines a range of IPv6 prefixes, from ‘2001:db8:0:79::/32’ to ‘2001:db8:0:139::/32’. These prefixes can be assigned to devices or subscribers that require IPv6 connectivity.

The IPv6 Prefix Delegation Pool is specified as ‘ipv6pd-local’. It defines the range of IPv6 from 2001:db8:0:1::/32 to ‘2001:db8:0:100::/32’. This pool is similar to the previous IPv6 pool, but is specifically meant for IPv6 Prefix Delegation.

```
supervisor@switch: cfg> show config access
{
  "rtbrick-config:access": {
    "pool": [
      {
        "pool-name": "ipv4-local",
        "ipv4-address": {
          "low": "198.51.100.76",
          "high": "198.51.100.117"
        }
      },
      {
        "pool-name": "ipv6-local",
        "ipv6-prefix": {
```

```
          "low": "2001:db8:0:79::/32",
          "high": "2001:db8:0:139::/32"
        }
      },
      {
        "pool-name": "ipv6pd-local",
        "ipv6-prefix": {
          "low": "2001:db8:0:1::/32",
          "high": "2001:db8:0:100::/32"
        }
      }
    ],
  }
}
```

API To access the RESTCONF API that corresponds to this CLI, click here.

Configuring IPv4 Address Pools

The following command and options allow you to configure an IPv4 address pool.

Syntax:

set access pool <pool-name> **ipv4-address high** <high>
set access pool <pool-name> **ipv4-address low** <low>
set access pool <pool-name> **ipv4-address subnet-mask** <subnet-mask>

Attribute	Description
high	Specifies the highest IPv4 address in the local address pool range that can be assigned to subscribers.
low	Specifies the lowest IPv4 address in the local address pool range that can be assigned to subscribers.
subnet-mask	Defines the subnet mask for the IPv4 address pool, determining the size and boundary of the address range.

API To access the RESTCONF API that corresponds to this CLI, click here.

Configuring IPv6 Prefix Pools

The following command and options allow you to configure an IPv6 prefix pools.

Syntax:

set access pool <pool-name> **ipv6-prefix high** <high>
set access pool <pool-name> **ipv6-prefix low** <low>
set access pool <pool-name> **next-pool-name** <next-pool-name>

Attribute	Description
high	Specifies the highest IPv4 address in the local address pool range that can be assigned to subscribers.
low	Specifies the lowest IPv6 address in the local address pool range that can be assigned to subscribers.

IPv6 prefixes must be at least /64 or larger (/56, /48, ...) or /128.

Configuring Linked Pools (Pool Chain)

RBFS enables pool linking. You can link or chain multiple IP address pools so that when a pool gets exhausted, the next pool defined will start performing address allocation. Pool linking allows the creation of discontinuous address pools connected together in a sequence, creating an extended pool. The pools are connected using the next-pool-name attribute.

Syntax:

set access pool <pool-name> **next-pool-name** <next-pool-name>

Example:

A - B - C - D

```
set access pool pool-A next-pool pool-B
set access pool pool-B next-pool pool-C
set access pool pool-C next-pool pool-D
```

The actual address pool assigned to a subscriber is determined by the access configuration profile or RADIUS, starting with the specified pool in the chain. If that pool is full, the system requests the next pool in sequence, continuing until an available pool is found or the end of the chain is reached. To prevent looping, RBFS halts automatically if it detects that any pool in the chain has been accessed twice.

Additionally, the system can continuously cycle through all available pools in the chain, even if allocation starts from a pool in the middle. This ensures every pool in the sequence gets considered till finding an available address.

The following configuration commands link a set of IP address pools in a cycle order. The 'pool-A' is linked with the 'pool-B', 'pool-C' is set as a next pool after the 'pool-B'. 'Pool-D' is specified as next pool for 'pool-C'. 'Pool-A' is set as the next pool for 'pool-A'.

A - B - C - D - A

```
set access pool pool-A next-pool pool-B
set access pool pool-B next-pool pool-C
set access pool pool-C next-pool pool-D
set access pool pool-D next-pool pool-A
```

API To access the RESTCONF API that corresponds to this CLI, click here.

Control Plane Outbound Marking Configuration

Control Plane Outbound Marking refers to the process of marking control plane packets as they exit the network device. This marking ensures that packets are processed in accordance with defined network policies, facilitating consistent and reliable traffic handling.

To mark all outbound control plane packets, configure the appropriate settings under forwarding-options. The following example demonstrates this configuration.

With these settings, control plane traffic is reliably identified and handled according to specified criteria, supporting an optimized network environment.

The following configuration marks outbound control plane packets with specific attributes, such as priority or type of service, to simplify their identification within the network.

This configuration defines how outbound control plane packets are marked by protocol under forwarding-options. Control Plane QoS settings ensure that control traffic is marked and prioritized appropriately. The outbound-marking specifies marking criteria for control plane traffic. In the example, the protocol and remark-types options are configured for L2TPv2, PPP, and RADIUS protocols.

Each protocol uses distinct marking settings:

- L2TPv2 packets are marked with a ToS codepoint of 64 to ensure they are handled with the designated priority as they traverse the network.
- PPP packets are marked with a p-bit (priority bit) value of 6, indicating their priority within the network.
- Similar to L2TPv2, RADIUS packets are marked with a ToS codepoint of 64, ensuring consistent priority treatment across protocols.

```
supervisor@switch: cfg> show config forwarding-options
{
    "rtbrick-config:forwarding-options": {
      "class-of-service": {
        "control-plane-qos": {
          "outbound-marking": {
            "protocol": [
              {
                "protocol": "l2tpv2",
                "remark-type": "tos",
                "codepoint": 64
              },
              {
                "protocol": "ppp",
                "remark-type": "p-bit",
                "codepoint": 6
              },
              {
                "protocol": "radius",
                "remark-type": "tos",
                "codepoint": 64
              }
            ]
          }
        }
      }
    }
  }
```

Configuration Examples

PPPoE

The following example shows a PPPoE configuration for VLAN mode 1:1 with IPv4 and IPv6 enabled, authenticated via RADIUS.

```
{
  "ietf-restconf:data": {
    "rtbrick-config:access": {
      "aaa-profile": [
        {
          "profile-name": "aaa-radius",
          "session-timeout": 0,
```

```
        "idle-timeout": 0,
        "aaa-radius-profile": "radius-default",
        "authentication": {
          "order": "RADIUS"
        },
        "accounting": {
          "order": "RADIUS",
        }
      }
    ],
    "radius-profile": [
      {
        "profile-name": "radius-default",
        "nas-identifier": "BNG",
        "nas-port-type": "Ethernet",
        "authentication": {
          "radius-server-profile-name": [
            "radius-server-1",
            "radius-server-2"
            ]
        },
        "accounting": {
          "radius-server-profile-name": [
            "radius-server-1",
            "radius-server-2"
            ],
          "stop-on-reject": "true",
          "stop-on-failure": "true",
          "accounting-on-off": "true",
          "accounting-on-wait": "true",
          "accounting-backup": "true",
          "accounting-backup-max": 86400
        }
      }
    ],
    "radius-server": [
      {
        "server-name": "radius-server-1",
        "address": "198.51.100.101",
        "source-address": "198.51.100.200",
        "secret-encrypted-text": "$21e4946e31b406de98b3077aef03ed5a7",
        "authentication": {
          "enable": "true"
        },
        "accounting": {
          "enable": "true"
        },
        "coa": {
          "enable": "true"
        }
      },
      {
        "server-name": "radius-server-2",
        "address": "198.51.100.102",
        "source-address": "198.51.100.200",
        "secret-encrypted-text": "$21e4946e31b406de98b3077aef03ed5a7",
        "authentication": {
          "enable": "true"
        },
        "accounting": {
          "enable": "true"
```

```
          },
          "coa": {
            "enable": "true"
          }
        }
      ],
      "access-profile": [
        {
          "profile-name": "pppoe-dual",
          "protocol": {
            "pppoe": {
              "enable": "true",
              "session-protection": {
                "enable": "true"
              },
              "vlan-priority": 6
            },
            "ppp": {
              "lcp": {
                "authentication-protocol": "PAP_CHAP",
                "echo-interval": 30,
                "echo-max-retransmit": 3,
                "echo-enable": "true"
              },
              "ipcp": {
                "enable": "true",
                "source-ifl": "lo-0/0/0/1"
              },
              "ip6cp": {
                "enable": "true"
              }
            },
            "ra": {
              "enable": "true",
              "interval": 60
            },
            "dhcpv6": {
              "enable": "true"
            },
            "l2tp": {
              "tunnel-profile": "l2tp-default"
            }
          },
          "address-family": {
            "ipv4": {
              "enable": "true",
              "primary-dns": "198.51.100.103",
              "secondary-dns": "198.51.100.104",
              "instance": "default"
            },
            "ipv6": {
              "enable": "true",
              "primary-dns": "2001:db8:0:100::",
              "secondary-dns": "2001:db8:0:104::",
              "instance": "default"
            }
          }
        }
      ],
      "interface": {
        "double-tagged": [
```

```
        {
          "interface-name": "ifl-0/0/1",
          "outer-vlan-min": 1,
          "outer-vlan-max": 4094,
          "inner-vlan-min": 7,
          "inner-vlan-max": 7,
          "access-type": "PPPoE",
          "access-profile-name": "pppoe-dual",
          "aaa-profile-name": "aaa-radius"
        }
      ]
    },
    "l2tp-profile": [
      {
        "profile-name": "l2tp-default",
        "session-limit": 4000,
        "client-name": "BNG",
        "client-ipv4": "198.51.100.200",
        "hide-authentication": true
      }
    ]
  },
  "rtbrick-config:interface": [
    {
      "name": "ifl-0/0/1",
      "description": "Access",
      "host-if": "eth0"
    },
    {
      "name": "ifl-0/0/2",
      "description": "Core",
      "host-if": "eth1",
      "unit": [
        {
          "unit-id": 1,
          "address": {
            "ipv4": [
              {
                "prefix4": "198.51.100.33/24"
              }
            ],
            "ipv6": [
              {
                "prefix6": "2001:db8:0:32::/32"
              }
            ]
          }
        }
      ]
    },
    {
      "name": "lo-0/0/0",
      "unit": [
        {
          "unit-id": 1,
          "address": {
            "ipv4": [
              {
                "prefix4": "198.51.100.200/24"
              }
            ]
```

```
            }
          }
        ]
      }
    ]
  }
}
```

IPoE

The following example shows an IPoE configuration for VLAN mode 1:1 with IPv4 and IPv6 enabled, authenticated via RADIUS.

```
{
  "ietf-restconf:data": {
    "rtbrick-config:access": {
      "aaa-profile": [
        {
          "profile-name": "aaa-radius",
          "session-timeout": 0,
          "idle-timeout": 0,
          "aaa-radius-profile": "radius-default",
          "authentication": {
            "order": "RADIUS"
          },
          "accounting": {
            "order": "RADIUS",
          }
        }
      ],
      "radius-profile": [
        {
          "profile-name": "radius-default",
          "nas-identifier": "BNG",
          "nas-port-type": "Ethernet",
          "authentication": {
            "radius-server-profile-name": [
              "radius-server-1",
              "radius-server-2"
              ]
          },
          "accounting": {
            "radius-server-profile-name": [
              "radius-server-1",
              "radius-server-2"
              ],
            "stop-on-reject": "true",
            "stop-on-failure": "true",
            "accounting-on-off": "true",
            "accounting-on-wait": "true",
            "accounting-backup": "true",
            "accounting-backup-max": 86400
          }
        }
      ],
      "radius-server": [
        {
```

```
        "server-name": "radius-server-1",
        "address": "198.51.100.101",
        "source-address": "198.51.100.200",
        "secret-encrypted-text": "$21e4946e31b406de98b3077aef03ed5a7",
        "authentication": {
          "enable": "true"
        },
        "accounting": {
          "enable": "true"
        },
        "coa": {
          "enable": "true"
        }
      },
      {
        "server-name": "radius-server-2",
        "address": "198.51.100.102",
        "source-address": "198.51.100.200",
        "secret-encrypted-text": "$21e4946e31b406de98b3077aef03ed5a7",
        "authentication": {
          "enable": "true"
        },
        "accounting": {
          "enable": "true"
        },
        "coa": {
          "enable": "true"
        }
      }
    ],
    "access-profile": [
      {
        "profile-name": "ipoe-dual",
        "protocol": {
          "dhcp": {
            "enable": "true",
            "mode": "server"
          },
          "dhcpv6": {
            "enable": "true",
            "mode": "server"
          },
        },
        "address-family": {
          "ipv4": {
            "enable": "true",
            "pool-name":"ipoe",
            "primary-dns": "198.51.100.103",
            "secondary-dns": "198.51.100.104",
            "instance": "default"
          },
          "ipv6": {
            "enable": "true",
            "pool-name":"ipoe-ia-na",
            "prefix-delegation-pool-name":"ipoe-ia-pd",
            "primary-dns": "2001:db8:0:100::",
            "secondary-dns": "2001:db8:0:104::",
            "instance": "default"
          }
        }
      }
```

```
      ],
      "interface": {
        "double-tagged": [
          {
            "interface-name": "ifl-0/0/1",
            "outer-vlan-min": 1,
            "outer-vlan-max": 4094,
            "inner-vlan-min": 7,
            "inner-vlan-max": 7,
            "access-type": "IPoE",
            "access-profile-name": "ipoe-dual",
            "aaa-profile-name": "aaa-radius",
            "gateway-ifl": "lo-0/0/0/1"
          }
        ]
      },
      "pool": [
        {
          "pool-name": "ipoe",
          "ipv4-address": {
            "low": "10.0.0.1",
            "high": "10.0.255.255"
          }
        },
        {
          "pool-name": "ipoe-ia-na",
          "ipv6-prefix": {
            "low": "fc66::1/128",
            "high": "fc66::ffff/128"
          }
        },
        {
          "pool-name": "ipoe-ia-pd",
          "ipv6-prefix": {
            "low": "fc66:0:100::/56",
            "high": "fc66:0:1ff:ff00::/56"
          }
        }
      ],
    },
    "rtbrick-config:interface": [
      {
        "name": "ifl-0/0/1",
        "description": "Access",
        "host-if": "eth0"
      },
      {
        "name": "ifl-0/0/2",
        "description": "Core",
        "host-if": "eth1",
        "unit": [
          {
            "unit-id": 1,
            "address": {
              "ipv4": [
                {
                  "prefix4": "198.51.100.33/24"
                }
              ],
              "ipv6": [
                {
```

```
                  "prefix6": "2001:db8:0:6423::/32"
                }
              ]
            }
          }
        ]
      },
      {
        "name": "lo-0/0/0",
        "unit": [
          {
            "unit-id": 1,
            "address": {
              "ipv4": [
                {
                  "prefix4": "198.51.100.200/24"
                }
              ]
            }
          }
        ]
      }
    ]
  }
}
```


5.1.3. Subscriber Management Operational Commands

Show Commands

The following commands are served by subscriber daemon and are applicable for all kinds of subscribers like PPPoE, L2TP or IPoE.

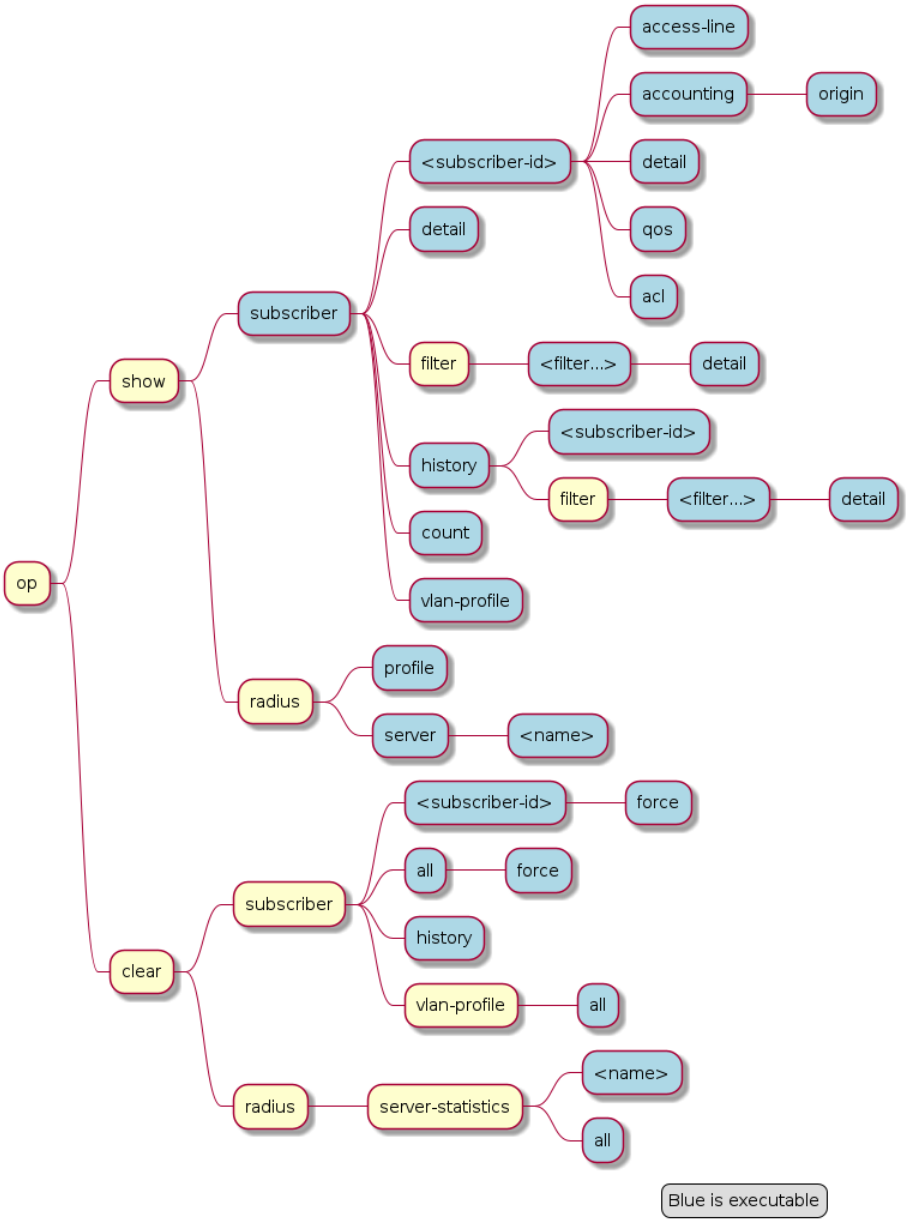


Figure 74. Subscriber Management Operational Commands

Subscribers

The term subscriber describes an access user or session from a higher level decoupled from underlying protocols like PPPoE or IPoE. Subscribers in RBFS can be managed locally or remote via RADIUS. Each subscriber is uniquely identified by a 64bit number called subscriber-id.

Subscriber States

A good starting point for troubleshooting subscriber services is to verify the status of the subscriber sessions. The state ESTABLISHED means that the session is fully operational.

```
supervisor@leaf1: op> show subscriber
Subscriber-Id          Interface        VLAN      Type   State
72339069014638600      ifp-0/0/1        1:1       PPPoE  ESTABLISHED
72339069014638601      ifp-0/0/1        1:2       PPPoE  ESTABLISHED
72339069014638602      ifp-0/0/1        1:3       PPPoE  ESTABLISHED
72339069014638603      ifp-0/0/3        2000:7    L2TP   ESTABLISHED
```

Alternative use show subscriber detail which shows further details like username, Agent-Remote-Id (aka Line-Id) or Agent-Circuit-Id if screen width is large enough to print all those information.

The meaning of the subscriber state is shown in the following table and diagram.

State	Description
INIT	Initial subscriber state.
AUTHENTICATING	Authenticate the subscriber using the configured method.
ADDRESS ALLOCATION	Allocate (RADIUS or pool) and validate (DAD) addresses.
TUNNEL SETUP	Setup tunnel resources (L2TP or L2X).
IFL SETUP	Create subscriber IFL with corresponding QoS resources.
FULL	Wait for subscriber to be in forwarding state. Inform underlying protocols (PPPoED or IPoED) to continue with session setup.
ACCOUNTING	Start subscriber accounting and wait for response.
ESTABLISHED	The subscriber becomes ESTABLISHED after response to RADIUS Accounting-Request-Start if RADIUS accounting is enabled otherwise immediately after FULL.
TERMINATING	The subscriber remains in this state until all resources are freed and accounting stopped. This means that subscriber remain in this state until response to RADIUS Accounting-Request-Stop if RADIUS accounting is enabled.

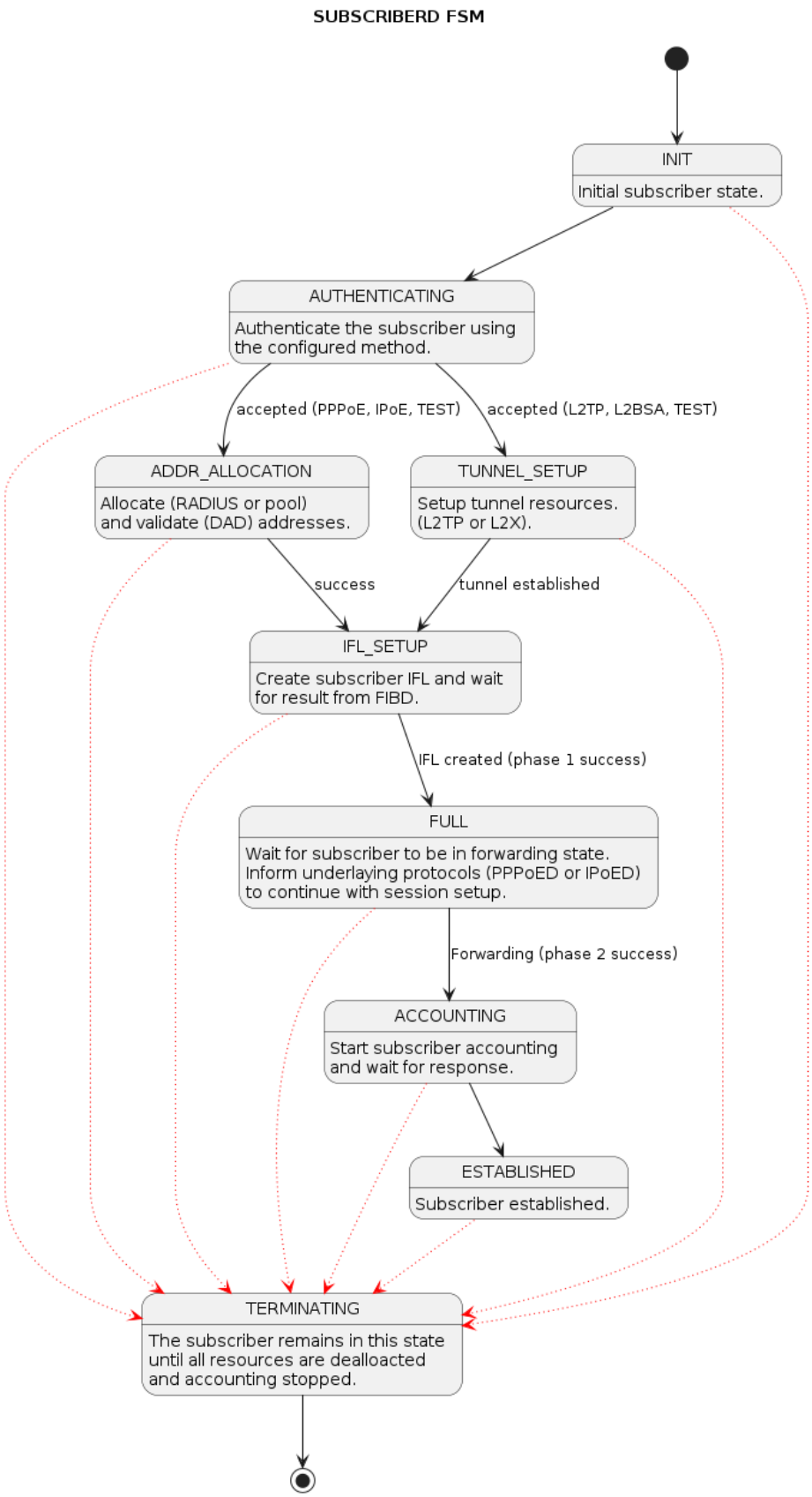


Figure 75. Subscriber States

For each subscriber a set of commands is available showing detailed information.

```
supervisor@leaf1: op> show subscriber 72339069014638594
  <cr>
  access-line           Subscriber access line information
  accounting            Subscriber accounting information
  acl                   Subscriber ACL information (filter)
  detail                Detailed subscriber information
  qos                   Subscriber QoS information

user@switch: op> show subscriber 72339069014638594 detail
Subscriber-Id: 72339069014638594
    Type: PPPoE
    State: ESTABLISHED
    Created: Fri Sep 18 20:50:02 GMT +0000 2020
    Interface: ifl-0/0/1
    Outer VLAN: 128
    Inner VLAN: 7
    Client MAC: fe:08:e8:ea:1d:32
    Server MAC: 7a:52:4a:01:00:01
    IFL: ppp-0/0/1/72339069014638594
    Username: 1122334455#123456789#0001@t-online.de
    Agent-Remote-Id: DEU.DTAG.1337
    Agent-Circuit-Id: 0.0.0.0/0.0.0.0 eth 1337
    Access-Profile: access-profile1
    AAA-Profile: aaa-profile1
    Session-Timeout: 30000
    Idle-Timeout: 120
    IPv4:
        Instance: default
        Address: 198.51.100.116/255.255.255.255
        Address Active: True
        Primary DNS: 198.51.100.213
        Secondary DNS: 198.51.100.54
    IPv6:
        Instance: default
        RA Prefix: 2001:db8:0:400::/32
        RA Prefix Active: True
        Delegated Prefix (DHCPv6): 2001:db8:0:269::/56
        Delegated Prefix Active: False
        Primary DNS: 2001:db8:0:92::
        Secondary DNS: 2001:db8:0:174::
    Accounting:
        Session-Id: 72339069014638594:1600462202
        Start-Time: 2020-09-18T20:50:02.738306+0000
        Interims Interval: 30 seconds
```

Subscriber Termination Codes

The following command shows the reasons why subscribers are terminated for the last 24 hours and up to 4000 subscribers.

```
supervisor@leaf1: op> show subscriber history
Subscriber-Id          Timestamp                              Terminate Code
72339069014638594      Fri Oct 16 20:17:33 GMT +0000 2020   Accounting-Request-On
Wait
72339069014638595      Fri Oct 16 20:32:19 GMT +0000 2020   PPPoE LCP Terminate
Request Received
```

Subscriber Count

To view a summary of PPPoE, L2TP, IPoE, and L2BSA subscribers in the Setup, Established, and Terminating state, use the "show subscriber count" command. This command provides information per interface and a total summary based on subscriber type.

The following example for subscriber count output displays the total number of subscribers on the system and categorizes them by state (Setup, Established, Terminating, and Standby) and by access type such as PPPoE, L2TP, and IPoE.

```
supervisor@rtbrick.net: op> show subscriber count
                       Total        Setup        Established  Terminating  Standby
Summary                10764        2203         0            8561         0
  PPPoE                798          564          0            234          0
  L2TP                 257          0            0            257          0
  IPoE                 9709         1639         0            8070         0
  L2BSA                0            0            0            0            0
  Test                 0            0            0            0            0
ifp-0/1/24             5702         1331         0            4371         0
  PPPoE                668          500          0            168          0
  L2TP                 172          0            0            172          0
  IPoE                 4862         831          0            4031         0
  L2BSA                0            0            0            0            0
  Test                 0            0            0            0            0
ifp-0/1/25             5062         872          0            4190         0
  PPPoE                130          64           0            66           0
  L2TP                 85           0            0            85           0
  IPoE                 4847         808          0            4039         0
  L2BSA                0            0            0            0            0
  Test                 0            0            0            0            0
```

Example output:

The command show subscriber count brief provides a filter to the existing subscriber count command, excluding lines with zero counts. This provides a clearer overview on systems with a large number of access interfaces. The output provides a summarized view of subscriber statistics, displaying totals and session states (Setup, Established, Terminating, and Standby) by access type and per interface.

```
supervisor@rtbrick.net: op> show subscriber count brief
                       Total        Setup        Established  Terminating  Standby
Summary                10790        1521         0            9269         0
  PPPoE                803          548          0            255          0
  L2TP                 272          0            0            272          0
  IPoE                 9715         973          0            8742         0
ifp-0/1/24             5688         952          0            4736         0
  PPPoE                653          472          0            181          0
```

```
  L2TP                181          0           0           181          0
  IPoE                4854         480         0           4374         0
ifp-0/1/25            5102         569         0           4533         0
  PPPoE               150          76          0           74           0
  L2TP                91           0           0           91           0
  IPoE                4861         493         0           4368         0
```

Example for subscriber count for specified interface. The output displays subscriber statistics specifically for the selected interface, including total sessions and their states. It also provides access-type information.

```
supervisor@rtbrick.net: op> show subscriber count interface ifp-0/1/24
                      Total        Setup        Established  Terminating  Standby
ifp-0/1/24            5621         939          0            4682         0
  PPPoE               614          434          0            180          0
  L2TP                179          0            0            179          0
  IPoE                4828         505          0            4323         0
  L2BSA               0            0            0            0            0
  Test                0            0            0            0            0
```

RADIUS

RADIUS Profile

The following command shows the status of all RADIUS profiles.

```
supervisor@leaf1: op> show radius profile
RADIUS Profile: radius-default
    NAS-Identifier: BNG
    NAS-Port-Type: Ethernet
    Authentication:
        Algorithm: ROUND-ROBIN
        Server:
            radius-server-1
            radius-server-2
    Accounting:
        State: UP
        Stop on Reject: True
        Stop on Failure: True
        Backup: True
        Algorithm: ROUND-ROBIN
        Server:
            radius-server-1
            radius-server-2
```

This meaning of the accounting state is explained in the table below.

Accounting States

Code	State	Description
0x00	DISABLED	Change profile accounting state from DISABLED to ACTIVE if at least one server referenced is found with accounting enabled.
0x01	ACTIVE	Server referenced by RADIUS profile but no response received
0x02	STARTING	Send accounting-on and wait for response.
0x05	UP	Change profile accounting state to UP if at least one referenced accounting server is UP.

The profile state becomes immediately ACTIVE if at least one of the referenced accounting servers can be found in RADIUS server table with accounting enabled. Otherwise the profile keeps DISABLED.

If RADIUS Accounting-On is enabled, the profile state becomes STARTING before UP. It is not permitted to send any accounting request start, interim or stop related to a profile in this state. It is also not permitted to send authentication requests if **accounting-on-wait** is configured in addition. The state becomes UP if at least one server in the accounting server list is in a state UP or higher (UNREACHABLE, DOWN, TESTING, DEAD).

A new profile added which references existing used RADIUS servers must not trigger a RADIUS Accounting-On request if at least one of the referenced servers is in a state of UP or higher.

RADIUS Server

The following command shows the status of all RADIUS servers.

```
supervisor@leaf1: op> show radius server
RADIUS Server            Address          Authentication State Accounting State
radius-server-1          198.51.100.64    ACTIVE               UP
radius-server-2          198.51.100.163   ACTIVE               ACTIVE
radius-server-3          198.51.100.104   ACTIVE               ACTIVE
```

This meaning of those states is explained in the table and diagram below.

Code	State	Description
0x00	DISABLED	RADIUS authentication (authentication state) or accounting (accounting state) is disabled or server not referenced by profile.
0x01	ACTIVE	Server referenced by RADIUS profile but no valid response received.
0x02	STARTING	This state is valid for accounting (accounting state) only during accounting-on is sending (wait for accounting-on response).
0x03	STOPPING	This state is valid for accounting (accounting state) only during accounting-off is sending (wait for accounting-off response).
0x04	FAILED	This state is valid for accounting (accounting state) only if accounting-on/off timeout occurs.
0x05	UP	Valid RADIUS response received
0x06	UNREACHABLE	No response received/timeout but server is still usable.
0x07	DOWN	Server is down but can be selected.
0x08	TESTING	Send a request to test if server is back again. The server will not be selected for another request in this state (use a single request to check if server is back again).
0x09	DEAD	Server is down and should not be selected.

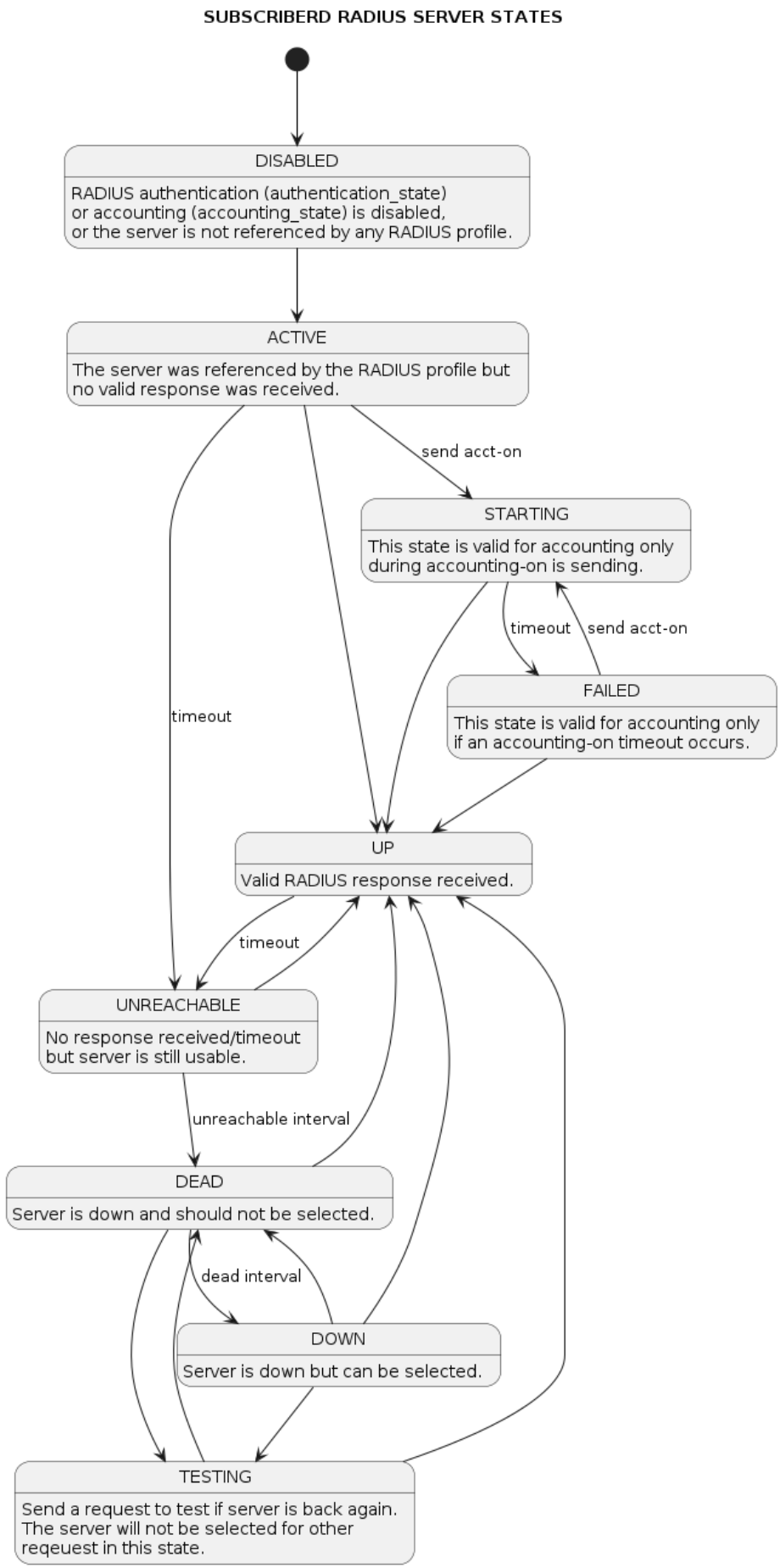


Figure 76. RADIUS Server States

For each server dedicated detailed information are displayed with the following commands.

```
supervisor@leaf1: op> show radius server radius-server-1
RADIUS Server: radius-server-1
    Address: 198.51.100.64
    Source: 198.51.100.200
    Rate: 600 PPS
    Rate Tokens: 600
    Dropped: 0
    Authentication:
        State: ACTIVE
        State Changed: Fri Oct 16 20:17:27 GMT +0000 2020
        Port: 1812
        Retry: 3
        Timeout: 5
        Outstanding: 100
        Statistics:
            Request Sent: 0
            Request Retry: 0
            Request Timeout: 0
            Accept Received: 0
            Reject Received: 0
            Dropped: 0
    Accounting:
        State: UP
        State Changed: Fri Oct 16 20:18:27 GMT +0000 2020
        Port: 1813
        Retry: 10
        Timeout: 30
        Outstanding: 100
        Statistics:
            Request Sent: 1
            Request Retry: 2
            Request Timeout: 0
            Response Received: 1
            Dropped: 0
    CoA:
        Port: 3799
        Statistics:
            Request Received: 0
            Dropped: 0
```

PPPoE

The following commands are applicable for PPPoE sessions only.

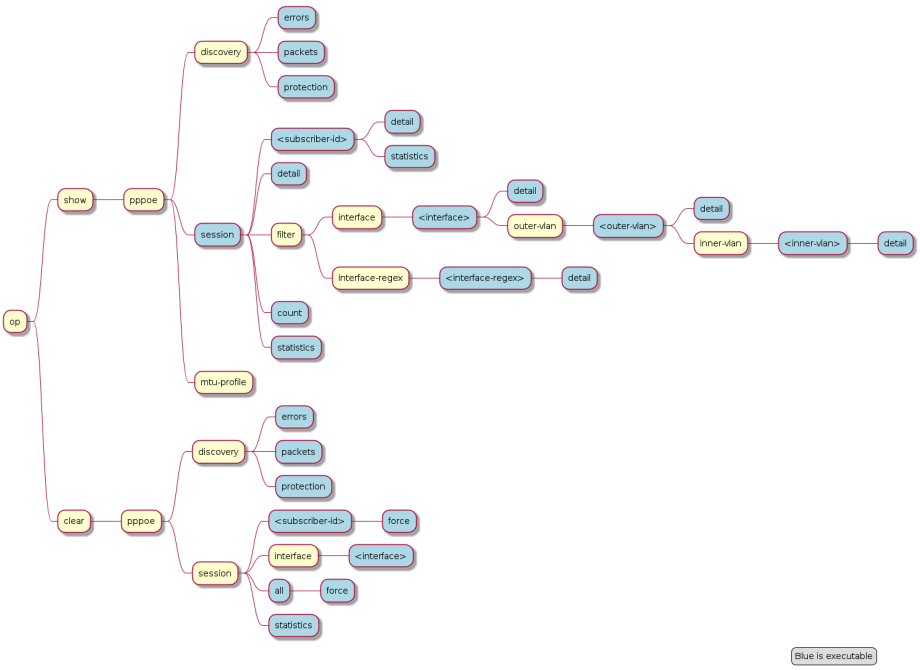


Figure 77. PPPoE Operational Commands

For PPPoE sessions the state should be ESTABLISHED if local terminated or TUNNELLED for L2TPv2 tunnelled sessions.

```
supervisor@rtbrick: op> show pppoe session
Subscriber-Id          Interface        VLAN      MAC               State
72339069014638604      ifp-0/0/1        1:1       00:04:0e:00:00:01 ESTABLISHED
72339069014638601      ifp-0/0/1        1:2       00:04:0e:00:00:02 ESTABLISHED
72339069014638602      ifp-0/0/1        1:3       00:04:0e:00:00:03 ESTABLISHED
72339069014638603      ifp-0/0/3        2000:7    52:54:00:57:c8:29 TUNNELLED
```

Alternative use show pppoe session detail which shows further details like username, Agent-Remote-Id (aka Line-Id) or Agent-Circuit-Id if screen width is large enough to print all those information.

State	Description
LINKING	PPP LCP setup.
AUTHENTICATING	PPP authentication (PAP or CHAP).
NETWORKING	PPP IPCP (IPv4) and IP6CP (IPv6) setup.
ESTABLISHED	The PPPoE session becomes established if at least one NCP (IPCP or IP6CP) is established (state OPEN).
TUNNELLED	This state indicates that a PPPoE session is tunnelled via L2TPv2.
TERMINATING	PPP session teardown.

State	Description
TERMINATED	PPPoE session terminated.

If PPPoE session remain in state TERMINATED, the subscriber state should be checked. Typically this happens if RADIUS Accounting-Request-Stop is still pending.

Further details per PPPoE session can be shown with the following commands.

```
supervisor@rtbrick: op> show pppoe session 72339069014638648
  <cr>
  detail                Detailed session information
  statistics            Protocol statistics
```

The detail command shows the states of the session and all sub-protocols with extensive information and negotiated parameters.

```
user@switch: op> show pppoe session 72339069014638648 detail
Subscriber-Id: 72339069014638648
    State: ESTABLISHED
    Uptime: Tue Nov 17 11:46:43 GMT +0000 2020 (0:00:21.979775)
    Interface: ifp-0/0/3
    Outer VLAN: 10
    Inner VLAN: 7
    Client MAC: 52:54:00:57:c8:29
    Server MAC: 7a:52:4a:c0:00:03
    Session-Id: 55
    Host-Unique: 00000001
    Agent-Remote-Id: DEU.RTBRICK.1
    Agent-Circuit-Id: 0.0.0.0/0.0.0.0 eth 1
    Access-Profile: pppoe-dual
    AAA-Profile: aaa-default
    PPP LCP:
        State: OPENED
        Negotiated Protocols: CHAP, IPCP, IP6CP
        Negotiated Parameters: MRU, AUTH, MAGIC
        Magic Number: 1079931229 Peer: 3432759752
        MRU: 1492 Peer: 1492
        MTU: 1492 Profile: __default_pppoe__
        Echo Interval: 30 seconds
    CHAP Authentication:
        State: COMPLETED
        Username: user1@rtbrick.com
    PPP IPCP:
        State: OPENED
        Instance: default
        IP Address: 198.51.100.200 Peer: 198.51.100.72
        Primary DNS: 198.51.100.88
        Secondary DNS: 198.51.100.54
    PPP IP6CP:
        State: OPENED
        Instance: default
        Interface Identifier: c5f6:1dbd:8cc1:bea9
        Peer Interface Identifier: 5054:00ff:fe57:c829
```

```
    IPv6:
        RA Interval: 60 seconds
        RA Prefix: 2001:db8:0:246::/32
        Delegated Prefix (DHCPv6): 2001:db8:0:9::/32 Assigned: True
        Primary DNS: 2001:db8:0:114::
        Secondary DNS: 2001:db8:0:115::
    Control Traffic Statistics:
        Ingress: 15 packets 1059 bytes
        Egress: 16 packets 1475 bytes
```

Session statistics are available global and per session.

```
supervisor@rtbrick: op> show pppoe session statistics
supervisor@rtbrick: op> show pppoe session 72339069014638601 statistics
```

The PPPoE discovery statistics are helpful if session setup fails in initial PPPoE tunnel setup before actual PPP negotiation is starting.

```
supervisor@rtbrick: op> show pppoe discovery packets
Packet           Received         Sent
PADI             17               0
PADO             0                17
PADR             17               0
PADS             0                17
PADT             1                13

supervisor@rtbrick: op> show pppoe discovery errors
PADI Drop No Config            : 0
PADI Drop Session Protection   : 0
PADI Drop Session Limit        : 0
PADI Drop Dup Session          : 0
PADI Drop Interface Down       : 0
PADR Drop No Config            : 0
PADR Drop Wrong MAC            : 0
PADR Drop Interface Down       : 0
PADR Drop Session Limit        : 0
PADR Drop Session Protection   : 0
PADR Drop Bad Cookie           : 0
PADR Drop Bad Session          : 0
PADR Drop Dup Session          : 0
PADR Drop No mapping Id        : 0
PADT Drop No Session           : 0
PADT Drop Wrong MAC            : 0
PADX Interface Get Failure     : 0
```

If PPPoE session protection is enabled in access configuration profile, short lived or failed sessions will be logged in the PPPoE session protection table (local.pppoe.session.protection).

Every session not established for at least 60 seconds per default is considered as failed or short lived session. This will block new sessions on this IFP and VLAN's for

one second per default which increase exponential with any further failed session until the max time of per default 300 seconds is reached. The interval is reset after 900 seconds without failed sessions.

The PPPoE session protection table include also last subscriber-id and terminate code which indicates the reason for session failures.

```
supervisor@rtbrick: op> show pppoe discovery protection
Interface        VLAN      Status  Attempts   Last Terminate Code
ifp-0/0/1        1:1       OK      1          PPPoE LCP Terminate Request Received
ifp-0/0/1        1:2       OK      1          PPPoE LCP Terminate Request Received
ifp-0/0/1        1:3       OK      1          PPPoE LCP Terminate Request Received
```

If status OK indicates that new session are accepted where BLOCKED means that sessions will be rejected.

The following example shows the aggregated PPPoE session control-plane statistics across all sessions on the device. The output provides counters for PPP negotiation for LCP, IPCP, and IP6CP.

```
supervisor@rtbrick: op> show pppoe session statistics
LCP configure-request received                        : 10
LCP configure-ack received                            : 10
LCP terminate-request received                        : 5
LCP terminate-ack received                            : 5
LCP echo-reply received                               : 5
LCP configure-request sent                            : 10
LCP configure-ack sent                                : 10
LCP terminate-request sent                            : 5
LCP terminate-ack sent                                : 5
LCP echo-request sent                                 : 5
LCP MRU negotiation successful                        : 10
LCP magic number negotiation successful               : 10
IPCP configure-request received                       : 20
IPCP configure-ack received                           : 10
IPCP configure-request sent                           : 10
IPCP configure-ack sent                               : 10
IPCP configure-nak sent                               : 10
IP6CP configure-request received                      : 10
IP6CP configure-ack received                          : 10
IP6CP configure-request sent                          : 10
IP6CP configure-ack sent                              : 10
PAP authentication-request received                   : 10
PAP authentication-ack sent                           : 10
ICMPv6 router-solicitation received                   : 10
ICMPv6 router-advertisement sent                      : 10
DHCPv6 solicit received                               : 10
DHCPv6 reply sent                                     : 10
```

The following example shows the PPPoE session statistics for a specific session. It

displays protocol message statistics for an individual PPPoE session identified by the session ID.

```
supervisor@rtbrick: op> show pppoe session 72339069014638599 statistics
LCP configure-request received                        : 1
LCP configure-ack received                            : 1
LCP echo-reply received                               : 1
LCP configure-request sent                            : 1
LCP configure-ack sent                                : 1
LCP echo-request sent                                 : 1
LCP MRU negotiation successful                        : 1
LCP magic number negotiation successful               : 1
IPCP configure-request received                       : 2
IPCP configure-ack received                           : 1
IPCP configure-request sent                           : 1
IPCP configure-ack sent                               : 1
IPCP configure-nak sent                               : 1
IP6CP configure-request received                      : 1
IP6CP configure-ack received                          : 1
IP6CP configure-request sent                          : 1
IP6CP configure-ack sent                              : 1
PAP authentication-request received                   : 1
PAP authentication-ack sent                           : 1
ICMPv6 router-solicitation received                   : 1
ICMPv6 router-advertisement sent                      : 1
DHCPv6 solicit received                               : 1
DHCPv6 reply sent                                     : 1
```

L2TP

The following commands are applicable for L2TP only.

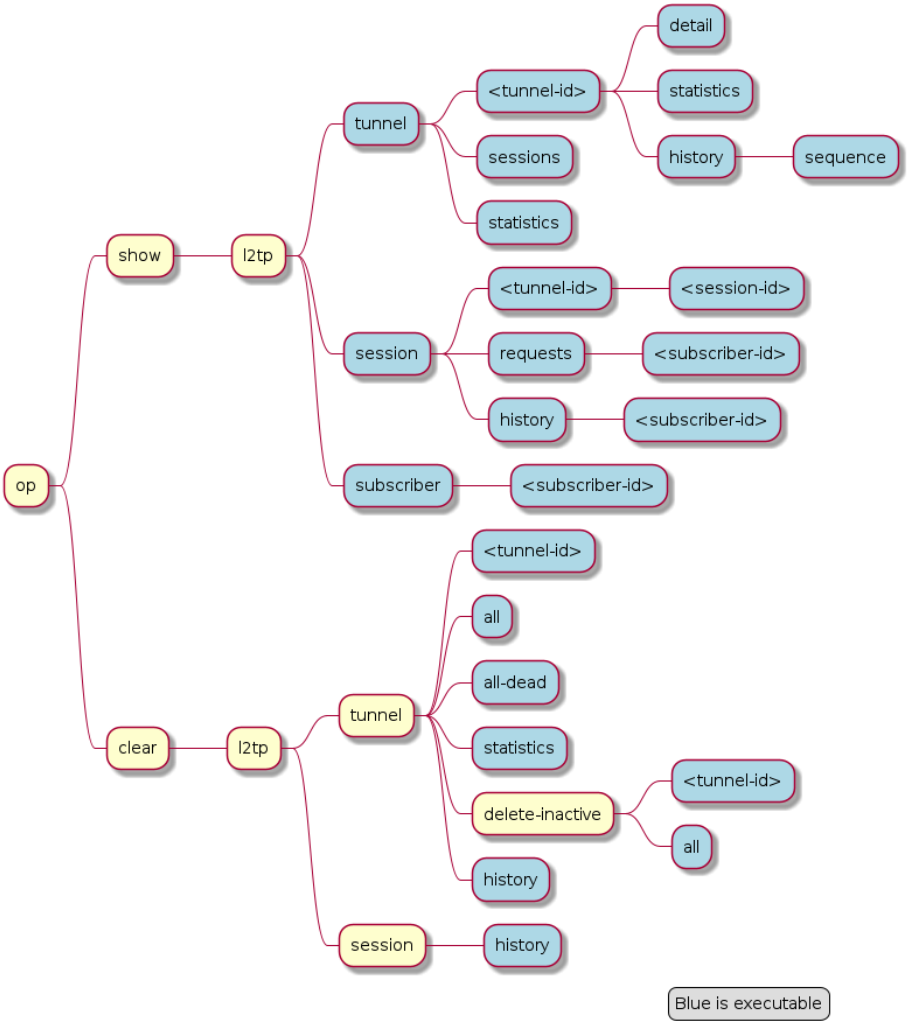


Figure 78. L2TP Operational Commands

For L2TPv2 tunnelled PPPoE sessions the global unique subscriber-id can be used to get information about the L2TP session.

```
supervisor@rtbrick: op> show l2tp subscriber 72339069014638621
Subscriber-Id: 72339069014638621
    State: ESTABLISHED
    Local TID: 45880
    Local SID: 39503
    Peer TID: 1
    Peer SID: 1
    Call Serial Number: 10
    TX Speed: 10007000 bps
    RX Speed: 1007000 bps
    CSUN: disabled
```

The following command gives a good overview over the corresponding tunnels.

```
supervisor@leaf1: op> show l2tp tunnel sessions
Role Local TID Peer TID State        Preference Sessions Established Peer Name
LAC       2022        1 ESTABLISHED       10000        1           1 LNS3
```

```
LAC       3274        1 ESTABLISHED       10000        1            1 LNS8
LAC      14690        1 ESTABLISHED       10000        1            1 LNS6
LAC      29489        1 ESTABLISHED       10000        1            1 LNS9
LAC      33323        1 ESTABLISHED       10000        1            1 LNS4
LAC      35657        1 ESTABLISHED       10000        1            1 LNS10
LAC      37975        1 ESTABLISHED       10000        1            1 LNS1
LAC      45880        1 ESTABLISHED       10000        1            1 LNS7
LAC      46559        1 ESTABLISHED       10000        1            1 LNS2
LAC      58154        1 ESTABLISHED       10000        1            1 LNS5
```

Detailed information per tunnel are available via show l2tp tunnel <TID> detail.

L2TP tunnel statistics are available global and per tunnel.

```
supervisor@leaf1: op> show l2tp tunnel statistics
supervisor@leaf1: op> show l2tp tunnel 37975 statistics
```

The following output provides a high-level summary of L2TP control plane activity, showing the total number of tunnels and sessions successfully established on the device.

```
supervisor@rtbrick: op> show l2tp tunnel statistics
Tunnel created              : 3
Tunnel initialized          : 3
Session created             : 5
SCCRQ sent                  : 3
SCCCN sent                  : 3
ICRQ sent                   : 5
ICCN sent                   : 5
SCCRP received              : 3
ZLB received                : 5
ICRP received               : 5
```

This following output provides the view of signaling activity specifically for L2TP tunnel '65244', detailing the control messages used to maintain that specific connection.

```
supervisor@rtbrick: op> show l2tp tunnel 65244 statistics
Session created             : 3
SCCRQ sent                  : 1
SCCCN sent                  : 1
ICRQ sent                   : 3
ICCN sent                   : 3
SCCRP received              : 1
ZLB received                : 1
ICRP received               : 3
```

L2TP Result and Disconnect Codes

The received result (RFC2661) and disconnect (RFC3145) code and message from CDN and StopCCN will be stored similar to the subscriber terminate history table for 24 hours and up to 1000 records.

```
supervisor@leaf1: op> show l2tp tunnel history
Sequence Local TID Peer TID Timestamp                              Terminate Code
       1     34209        0 Wed Jul 28 13:02:35 GMT +0000 2021   Admin Request
       2     39860        1 Wed Jul 28 13:02:35 GMT +0000 2021   Admin Request
       3     39860        2 Wed Jul 28 13:02:54 GMT +0000 2021   Admin Request
       4     39860        3 Wed Jul 28 13:04:29 GMT +0000 2021   StopCCN Received
(Requester is being shut down)
       5     39860        1 Wed Jul 28 13:06:19 GMT +0000 2021   StopCCN Received
(Requester is being shut down)

supervisor@leaf1: op> show l2tp tunnel history 4
Local TID: 39860 Peer TID: 3
    Terminate Code: StopCCN Received
    Timestamp: Wed Jul 28 13:04:29 GMT +0000 2021
    Local Address: 198.51.100.102
    Peer Address: 198.51.100.133
    Peer Name: LNS1
    Tunnel-Client-Auth-ID: BNG
    Tunnel-Server-Auth-ID: LNS1
    Result Code: Requester is being shut down

supervisor@leaf1: op> show l2tp session history
Subscriber-Id          Local TID Local SID Terminate Code
72339069014638614          39860      5597 Clear Session
72339069014638615          39860      5208 Clear Session
72339069014638623          39860     29626 Clear Session
72339069014638624          39860     42480 L2TP Tunnel Down
72339069014638625          39860     34417 L2TP Tunnel Down
72339069014638626          39860     20229 L2TP Tunnel Down
```

The show subscriber history <subscriber-id> command will also return L2TP details if found for the corresponding subscriber.

```
supervisor@leaf1: op> show subscriber history 72339069014638703
Subscriber-Id: 72339069014638703
    Terminate Code: L2TP CDN Request
    Timestamp: Wed Jul 28 13:06:18 GMT +0000 2021
    Interface: ifl-0/0/1
    Outer VLAN: 1000
    Inner VLAN: 2002
    Client MAC: 02:00:00:00:00:04
    Username: blaster@l2tp.de
    Agent-Remote-Id: DEU.RTBRICK.2
    Agent-Circuit-Id: 0.0.0.0/0.0.0.0 eth 0:2
    Accounting-Session-Id: 72339069014638703:1627477569
    L2TP Disconnect Cause:
        Code: Normal disconnection (LCP terminate-request)
        Protocol: 0
        Direction: Peer
```

```
        Message: N/A
```

The following output shows information related to L2TP tunnel and session establishment. The output includes statistics for tunnel creation, initialization, and control messages exchanged during the L2TP control-plane signaling process.

```
supervisor@rtbrick: op> show l2tp tunnel statistics
Tunnel created              : 3
Tunnel initialized          : 3
Session created             : 5
SCCRQ sent                  : 3
SCCCN sent                  : 3
ICRQ sent                   : 5
ICCN sent                   : 5
SCCRP received              : 3
ZLB received                : 5
ICRP received               : 5
```

IPoE

The following commands are applicable for IPoE subscribers only.

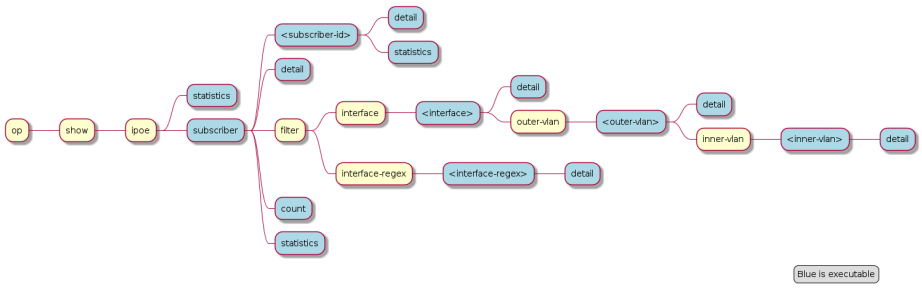


Figure 79. IPoE Operational Commands

```
supervisor@leaf1: op> show ipoe subscriber detail
Subscriber-Id          Interface        VLAN      MAC               State
DHCPv4     DHCPv6
216454257090494465     ifl-0/0/1     8:1       02:00:00:00:00:01 ESTABLISHED
Bound      Bound
216454257090494466     ifl-0/0/1     8:2       02:00:00:00:00:02 ESTABLISHED
Bound      Bound
216454257090494467     ifl-0/0/1     8:3       02:00:00:00:00:03 ESTABLISHED
Bound      Bound
216454257090494468     ifl-0/0/1     8:4       02:00:00:00:00:04 ESTABLISHED
Bound      Bound
```

Further details per subscriber can be shown with the following command.

```
supervisor@leaf1: op> show ipoe subscriber 216454257090494465 detail
Subscriber-Id: 216454257090494465
    State: ESTABLISHED
```

```
    Uptime: Mon Jun 14 15:46:15 GMT +0000 2021 (0:02:19.421591)
    Interface: ifl-0/0/1
    Outer VLAN: 8
    Inner VLAN: 1
    Client MAC: 02:00:00:00:00:01
    Gateway Interface: lo-0/0/0/1
    Gateway Instance: default
    Gateway IPv4: 198.51.100.200/255.255.255.255
    Gateway MAC: 7a:52:4a:c0:00:01
    Agent-Remote-Id: DEU.RTBRICK.1
    Agent-Circuit-Id: 0.0.0.0/0.0.0.0 eth 0:1
    DHCPv4:
        Mode: Server
        State: Bound
        Address: 198.51.100.202/255.255.255.255
        Lease Created: Mon Jun 14 15:46:15 GMT +0000 2021 (0:02:19.427443)
        Lease Time: 300 seconds
        Lease Expire: 161 seconds
    DHCPv6:
        Mode: Server
        State: Bound
        Client DUID: 0003000102000000001
        Server DUID: 0003001b78524afffec00001
        IA_NA:
            Address: 2001:db8:0:96
            IAID: 1181407340
            Active: True
        IA_PD:
            Prefix: 2001:db8:0:333/32
            IAID: 4095128883
            Active: True
        Lease Created: Mon Jun 14 15:46:15 GMT +0000 2021 (0:02:19.428676)
        Lease Time (Lifetime): 14400 seconds
        Lease Expire: 14261 seconds
        Preferred Lifetime: 1800 seconds
```

Local Address Pools



Rather than using recommended IP addresses for technical documents, the document shows actual IP pool ranges.

The usage of local address pools can be monitored using the show subscriber pool commands as shown below.

```
supervisor@switch: op> show subscriber pool summary
Pool Name                       AFI  Usage          Range
pool-A                          IPv4 256/256        10.0.1.0 - 10.0.1.255
pool-B                          IPv4 2/256          10.0.2.0 - 10.0.2.255
pool-C                          IPv4 0/256          10.0.3.0 - 10.0.3.255
pool-D                          IPv4 0/256          10.0.4.0 - 10.0.4.255

supervisor@switch: op> show subscriber pool ipv4 pool-A
Pool Name: pool-A
    AFI: IPv4
    Usage: 256/256
    Range: 10.0.1.0 - 10.0.1.255
```

```
    Next: pool-B

supervisor@switch: op> show subscriber pool ipv4 pool-B
Pool Name: pool-B
    AFI: IPv4
    Usage: 2/256
    Range: 10.0.2.0 - 10.0.2.255
    Next: pool-C

supervisor@switch: op> show subscriber pool ipv4 pool-B allocation
Subscriber-Id          Timestamp                          Address/Prefix
72339069014638598      Wed Sep 15 09:02:15 GMT +0000 2021   10.0.2.0
72339069014638602      Wed Sep 15 09:02:15 GMT +0000 2021   10.0.2.1
```

5.1.4. Supported Standards



RFC and draft compliance are partial except as specified.

PPPoE

- RFC 1516
- RFC 1661 (partly)
- RFC 1332 (partly)
- RFC 5072 (partly)
- RFC 1334 (partly)
- RFC 4638

RADIUS

- RFC 2865 (partly)
- RFC 3162 (partly)
- RFC 2866 (partly)
- RFC 4372 (partly)
- RFC 2869 (partly)

DHCPv4

- RFC 951 (partly)
- RFC 1542 (partly)
- RFC 2131 (partly)

- RFC 2132 (partly)
- RFC 3046 (partly)

DHCPv6

- RFC 8415 (partly)

Access Line Information

The access line identification and characterization information are defined in the Broadband Forum (BBF) formerly known DSL Forum attributes including Agent-Remote-Id and Agent-Circuit-Id.

See the following references for more information about access line attributes.

- RFC 4679 DSL Forum Vendor-Specific RADIUS Attributes
- RFC 6320 ANCP (partly)
- Broadband Forum TR-101 (partly)
- draft-lihawi-ancp-protocol-access-extension-04 (partly)

L2TPv2



RFC and draft compliance are partial except as specified.

RFC 2661 - Layer Two Tunneling Protocol (L2TPv2)

RFC compliant L2TPv2 Access Concentrator (LAC) with the following protocol limitations:

- No support for LNS initiated outbound calls (OCRQ, OCRP and OCCN)
- No support for WAN-Error-Notify (WEN) Messages send by LAC to LNS
- No support for Set-Link-Info (SLI) Messages send by LNS to LAC
- No support for L2TP over IPv6
- No support for L2TP offset values other than 0.

RFC 5515 - L2TP Access Line Information AVP Extensions

- Support for access line AVP send (LAC) and received (LNS) as part of the L2TP

Incoming-Call- Request (ICRQ) message.

- Response to Connect-Speed-Update-Request (CSURQ) L2TP messages is currently not supported.

RFC 2868 - RADIUS Attributes for Tunnel Protocol Support

RADIUS support for L2TP with the following limitations:

- No support of FQDN format for IP addresses
- No support Tunnel-Medium-Type other than IPv4

RFC 3145 - L2TP Disconnect Cause Information

Send meaningful disconnect cause information to LNS and display received disconnect cause information for tunnels and sessions.

Supported Hardware

You can find more detailed information about what RtBrick features are supported on each hardware platform, see the *Platform Guide*.

5.2. RBFS RADIUS Services

5.2.1. RADIUS Services Overview

The modular, scalable subscriber management that RtBrick calls the next generation access infrastructure (ng-access) provides support for protocols such as PPPoE, IPoE, L2TP and RADIUS.

The subscriber management infrastructure provides the next generation of internet access protocols designed for carrier grade services in regards to scalability and robustness. One of the challenges for carrier networks is interwork with numerous client devices which requires a well implemented, industry proven access protocol stack, including support for all relevant RFCs.

This implementation is designed to be a set of distributed services for increased scaling and stability. The subscriber management implementation has three components:

- subscriberd: subscriber management and AAA (local, RADIUS, and other

support)

- pppoed: PPPoE/PPP session handling
- l2tpd: L2TP tunnel and session handling

The subscriber daemon (subscriberd) is the central application, keeping the current subscriber state as well as being responsible for Authentication, Authorization and Accounting (AAA).

This document describes the subscriber management RADIUS service implementation on RBFS. The term subscriber describes an access user or session from a higher level decoupled from underlying protocols like PPPoE or IPoE. Subscribers in RBFS can be managed locally or via RADIUS where this document considers RADIUS only. Each subscriber is uniquely identified by a 64bit number called subscriber-id. Remote Authentication Dial-In User Service (RADIUS) is a networking protocol that provides centralized Authentication, Authorization and Accounting (AAA) management for all types of subscribers (PPPoE, or IPoE). RADIUS servers can perform as authentication and accounting servers or change of authorization (CoA) clients. Authentication servers maintain authentication records for subscribers. The subscriber daemon requests authentication in RADIUS access-request messages before permitting subscribers access. Accounting servers handle accounting records for subscribers. The subscriber daemon transmits RADIUS accounting-start, interim and stop messages to the servers. Accounting is the process of tracking subscriber activity and network resource usage in a subscriber session. This includes the session time called time accounting and the number of packets and bytes transmitted during the session called volume accounting.

A RADIUS server can behave as a change of authorization (CoA) client allowing dynamic changes for subscriber sessions. The subscriber daemon supports both RADIUS CoA messages and disconnect messages. CoA messages can modify the characteristics of existing subscriber sessions without loss of service, disconnect messages can terminate subscriber sessions.

Each RADIUS request from subscriber daemon includes the RADIUS accounting-session-id attribute (type 44) with a format which is configurable in the AAA profile and includes at least the subscriber-id to identify the corresponding subscriber. The default format (<subscriber-id>.<timestamp>) includes also an Unix timestamp to ensure that the tuple of NAS-Identifier (e.g. hostname) and Accounting-Session-Id is global unique to be usable as key in RADIUS databases.

Additionally to subscriber-id and accounting-session-id each subscriber consists also of a subscriber-ifl build based on physical port information and subscriber-id (ifp: ifp-0/0/1 and subscriber-id: 72339069014638610 subscriber-ifl: ppp-0/0/1/72339069014638610) which is required as handle in the RBFS forwarding infrastructure. All those three informations are part of the RADIUS access-request message:

- accounting-session-id: standard attribute 44
- subscriber-id: RtBrick VSA (26-50058-25 RtBrick-Subscriber-Id)
- subscriber-ifl: RtBrick VSA (26-50058-26 RtBrick-Subscriber-Ifl)

```
Code: Access-Request (1)
Packet identifier: 0x22 (34)
Length: 416
Authenticator: e61a0dd74c74704f608688b08de1dfba
[The response to this request is in frame 12]
▼ Attribute Value Pairs
  ▶ AVP: t=User-Name(1) l=19 val=user1@rtbrick.com
  ▶ AVP: t=CHAP-Challenge(60) l=18 val=2f696f4e920b47cab869021feb2bf632
  ▶ AVP: t=CHAP-Password(3) l=19 val=02f439040e9feb7bbc9e7622a364344913
  ▶ AVP: t=NAS-IP-Address(4) l=6 val=1.1.1.1
  ▶ AVP: t=NAS-Identifier(32) l=5 val=BNG
  ▶ AVP: t=NAS-Port-Id(87) l=59 val=BNG#hostif-0/0/4#10#7#0.0.0.0/0.0.0.0 eth 1#DEU.RTBRICK.1
  ▶ AVP: t=NAS-Port(5) l=6 val=67149831
  ▶ AVP: t=NAS-Port-Type(61) l=6 val=Ethernet(15)
  ▶ AVP: t=Service-Type(6) l=6 val=Framed(2)
  ▶ AVP: t=Framed-Protocol(7) l=6 val=PPP(1)
  ▶ AVP: t=Acct-Session-Id(44) l=30 val=72339069014638895:1589876315
  ▶ AVP: t=Vendor-Specific(26) l=13 vnd=RtBrick Inc.(50058)
  ▶ AVP: t=Vendor-Specific(26) l=20 vnd=RtBrick Inc.(50058)
  ▶ AVP: t=Vendor-Specific(26) l=16 vnd=RtBrick Inc.(50058)
  ▶ AVP: t=Vendor-Specific(26) l=25 vnd=RtBrick Inc.(50058)
  ▼ AVP: t=Vendor-Specific(26) l=16 vnd=RtBrick Inc.(50058)
      Type: 26
      Length: 16
      Vendor ID: RtBrick Inc. (50058)
    ▶ VSA: t=RtBrick-Subscriber-Id(25) l=10 val=010100000000012f
  ▼ AVP: t=Vendor-Specific(26) l=35 vnd=RtBrick Inc.(50058)
      Type: 26
      Length: 35
      Vendor ID: RtBrick Inc. (50058)
    ▶ VSA: t=RtBrick-Subscriber-Ifl(26) l=29 val=ppp-0/0/4/72339069014638895
  ▶ AVP: t=Vendor-Specific(26) l=29 vnd=The Broadband Forum(3561)
  ▶ AVP: t=Calling-Station-Id(31) l=23 val=0.0.0.0/0.0.0.0 eth 1
  ▶ AVP: t=Vendor-Specific(26) l=21 vnd=The Broadband Forum(3561)
  ▶ AVP: t=Vendor-Specific(26) l=18 vnd=The Broadband Forum(3561)
```

Figure 80. RADIUS Services Overview



The subscriber-id is an unsigned 64bit integer which is shown as a hex number in Wireshark.

Each subscriber is formed based on configuration profiles and individual settings retrieved via RADIUS. Conflicts between RADIUS defined attributes and profile

attributes are solved by prioritizing those received from RADIUS which is common best practices for broadband access concentrators. New subscribers are signalled via RADIUS access-request and either accepted by RADIUS access-accept or rejected by RADIUS access-reject message from RADIUS server. The RADIUS access-accept includes all attributes required to form the subscriber like IP addresses, DNS servers and referenced configuration profiles. Some of those attributes can be changed by RADIUS dynamically using CoA requests without disconnecting the subscriber.

Some of those attributes refer to RADIUS services which are described in detail in this document. The term RADIUS services described the ability to dynamically control the properties of a session via RADIUS used by access providers to build their different products and services based on their network infrastructure. This is used to control QoS settings like shaper rates dynamically based on changed line quality or possible volume quotas. It is also used to dynamically enable or disable services like Voice or IPTV on a per subscriber basis.

The RADIUS accounting accuracy should comply with §45g of the German Telecommunications Act (TKG) further named by TKG§45. This applies for time and volume based products and services. Products or services with unlimited volumes but with changed properties after a certain amount of traffic are considered as volume based products as well. One example here is a fair use policy which enforces a rate limit after a certain volume. The requirements for time based accounting apply only to products or services which are charged by time or changed properties after a certain time which is not very common in the market today.

Supported Platforms

Not all features are necessarily supported on each hardware platform. Refer to the *Platform Guide* for the features and the sub-features that are or are not supported by each platform.

5.2.2. RADIUS Service Solution Overview

The general concept of RADIUS services in RtBrick FullStack (RBFS) consists of pre-configured profiles in the global static configuration assigned to dynamic subscribers via RADIUS VSA in access-accept and CoA request messages. The profiles are managed as any other configuration in RBFS via corresponding API which is not explained here in detail.

The following pictures show the concept of global static configurations referenced by RADIUS controlled dynamic subscribers.

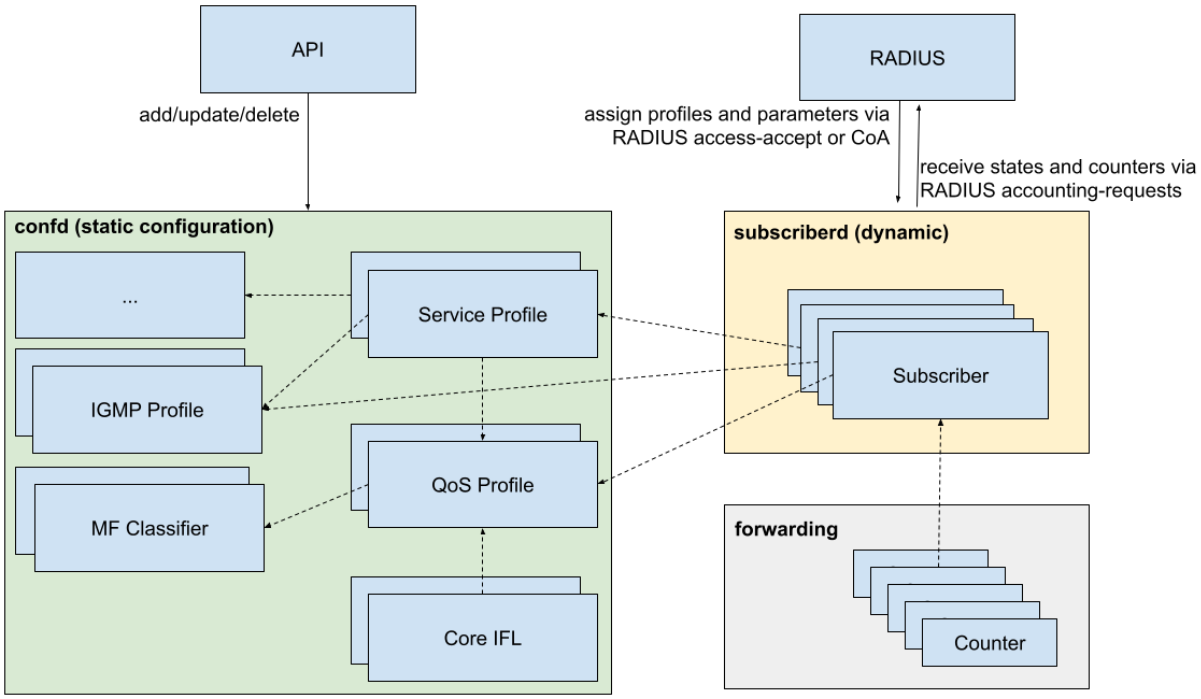


Figure 81. RADIUS Service Solution

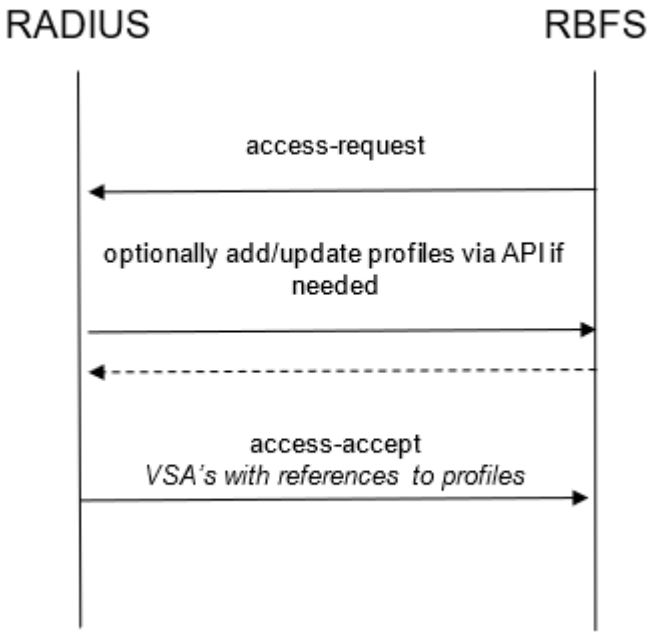


Figure 82. RADIUS Profiles and Filters

The required profiles and filters should be present before service becomes active which can be done immediately after start-up or between access-request and access-accept as shown in the flow diagram.

5.2.3. RADIUS Control

This chapter explains the subscriber and service-related RBFS extensions and RtBrick VSA related to RADIUS services.

RADIUS Session and Idle Timeout

The session and idle timeout values are initialized with zero, which means infinity or disabled. Those values will be optionally overwritten with the values in AAA configuration profile and RADIUS access-accept if present. The priority is RADIUS attributes over AAA configuration profile.

The session (attribute 27) and idle (attribute 28) timeout RADIUS attributes are defined in RFC 2865.



RFC and draft compliance are partial except as specified.

The idle timeout is based on outgoing logical interface statistics (OutLIF) for the subscriber-ifl to determine subscriber inactivity.

RADIUS Routing Instance

VSA 26-50058-137 - RtBrick-Instance

This attribute is applicable to non-IPoE subscribers only. It allows to change the routing instance through a RADIUS access-accept message.

For IPoE subscribers, the routing instance is automatically determined based on the gateway IFL.

RADIUS Gateay-Ifl

VSA 26-50058-138 - RtBrick-Gateway-Ifl

This attribute is applicable to IPoE subscribers only. It allows to change the actual gateway IFL. Consequently, this also indirectly modifies the routing instance through a RADIUS Access-Accept message.

RADIUS DNS Server

VSA 26-50058-131 - RtBrick-DNS-Primary

VSA 26-50058-132 - RtBrick-DNS-Secondary

VSA 26-50058-134 - RtBrick-DNS-Primary-IPv6

VSA 26-50058-135 - RtBrick-DNS-Secondary-IPv6

Those attributes allow to set the primary and secondary IPv4 and IPv6 DNS servers via RADIUS access-accept. DNS servers already set via access configuration profile will be overwritten by RADIUS.

RADIUS Service Profile

VSA 26-50058-70 - RtBrick-Service-Profile

Subscribers can be associated with a service-profile which defines the actual service properties like QoS or IGMP profiles and configuration settings. The service profile can be assigned or changed using the RtBrick-Service-Profile VSA.

```
RtBrick-Service-Profile = <service-profile>
```

This attribute is supported via RADIUS access-accept and CoA requests.

All dynamic QoS settings like shaper and policer rates will be reset if the new service-profile includes a qos-profile attribute also if active qos-profile and old qos-profile is equal. All QoS settings remain unchanged if the referenced service profile does not include the qos-profile attribute. If the referenced service profile updates the qos-profile attribute and additional shaper or policer rates are included in the same CoA request which updates the service-profile, those shaper and policer settings will be applied to the new QoS configuration profile after reset. This means that we reset all incremental changes done before. In example if Voice shaper rate has changed to another value, after profile change the default value from profile is used.

RADIUS CoA requests referencing a service profile which is not found on device will be rejected with CoA-NAK (invalid-request) but without changing any subscriber QoS settings. This behavior is different for RADIUS access-accept where service profiles are just ignored if not found. In both cases a warning is generated in subscriber daemon log if a referenced service profile is not found.

RADIUS AAA Profile

VSA 26-50058-69 - RtBrick-AAA-Profile

This attribute allows to change the associated AAA profile from RADIUS access-accept. This is primarily used to change the accounting adjustment values which are defined in this profile. Simple example here is to use different adjustment values for L2TP and local terminated PPPoE sessions. Another valid use case is to assign different RADIUS accounting servers for in example L2TP sessions or wholesale customers.

```
RtBrick-AAA-Profile = <aaa-profile>
```

This attribute is supported via RADIUS access-accept only.

RADIUS QoS Profile

VSA 26-50058-62 - RtBrick-QoS-Profile

```
RtBrick-QoS-Profile = <qos-profile>
```

This attribute is supported by RADIUS access-accept and CoA request. The QoS configuration profile can be either selected via service-profile or directly using this attribute which has priority of the service-profile.

All dynamic QoS settings like MFC, queue sizes, shaper and policer rates will be reset if this attribute is present in a CoA request also if new qos-profile and old qos-profile is equal. If additional shaper or policer rates are included in the same CoA request which updates the service-profile, those shaper and policer settings will be applied to the new QoS configuration after reset.

The subscriber management infrastructure does not check if a referenced QoS profile exists or not. This is handled by forwarding infrastructure which continues processing the subscriber QoS settings as soon as the profile was added. In the meantime there is no QoS configuration applied.

RADIUS QoS Parent Scheduler

VSA 26-50058-64 - RtBrick-QoS-Parent-Scheduler

The parent scheduler element of the scheduler-map assigned to the subscriber

can be selected with this attribute. If not present, the scheduler-map will be directly bound to the local IFP where the session is established.

This attribute is supported in RADIUS access-accept only (no CoA support) and will set the parent scheduler element of the subscriber.



Providing a QoS parent scheduler which is not present on the corresponding IFP will lead to black howling of all egress data traffic. Control traffic is not impacted and therefore the session will remain.

RADIUS QoS Shaper

VSA 26-50058-63 - RtBrick-QoS-Shaper

Subscribers can be associated with a QoS profile which is assigned via service-profile or directly via corresponding VSA (RtBrick-QoS-Profile). This profile is used to instantiate the QoS resources for the subscriber including schedulers, queues and shapers. The assigned shaper instances can be updated using the RtBrick-QoS-Shaper VSA (attribute 26-50058-63) which will apply to the QoS instance of the corresponding subscriber only, but not to the other subscribers using the same QoS profile. It is only possible to update existing shapers dynamically but it is not possible to create a new shaper via RADIUS.

The RtBrick-QoS-Shaper value is a string which contains a list of multiple shaper settings separated by semicolon. Each shaper setting contains a shaper name, high flow rate and low flow rate separated by comma. The actual shaper rate is the sum of high and low flow rate.

```
RtBrick-QoS-Shaper = <shaper-name>,<high-kbps>,<low-kbps>;<shaper-name>,...
```

This attribute can be also used as a key-value list which is automatically recognized by RBFS.

```
RtBrick-QoS-Shaper = name=<shaper-name>,high=<high-kbps>,low=<low-kbps>;...
```

This attribute is supported by RADIUS access-accept and CoA request.

Updating a single shaper (e.g. voice_shaper) via CoA does not require to include other shapers meaning that only the shapers included in the attribute will be

updated and all other shapers remain unchanged.

Assume the following example which adapts the session and voice shaper instance of a subscriber.

```
supervisor@rtbrick: op> show config forwarding-options class-of-service shaper
shaper_session
{
  "rtbrick-config:shaper": {
    "shaper-name": "shaper_session",
    "shaping-rate-high": 48000,
    "shaping-rate-low": 2000
  }
}
supervisor@rtbrick: op> show config forwarding-options class-of-service shaper
shaper_voice
{
  "rtbrick-config:shaper": {
    "shaper-name": "shaper_voice",
    "shaping-rate-high": 1000,
    "shaping-rate-low": 0
  }
}
```

RADIUS VSA Change Session Shaper Only

```
RtBrick-QoS-Shaper: shaper_session,14000,2000
```

RADIUS VSA Change Session and Voice Shaper

```
RtBrick-QoS-Shaper: shaper_session,14000,2000;shaper_voice,2000
```

All active dynamic shapers are stored in the table **global.access.1.subscriber.qos.shaper** to handover those information to forwarding infrastructure. This table can be used to verify the dynamic shapers which are active for a given subscriber.

The CLI command show subscriber <id> qos displays those information in a nice human readable format.

```
supervisor@rtbrick: op> show subscriber 72339069014638610 qos
Subscriber-Id: 72339069014638610
    Interface: ifp-0/0/1
    Outer VLAN: 128
    Inner VLAN: 7
    IFL: ppp-0/0/1/72339069014638610
    Profile: qos_profile
    Parent: pon1
```

```
    Dynamic Shaper: shaper_voice
        Rate Low: 0 kbps
        Rate High: 2000 kbps
    Dynamic Shaper: shaper_session
        Rate Low: 2000 kbps
        Rate High: 14000 kbps
```



A shaper rate of 0 means infinity!

RADIUS QoS Policer

VSA 26-50058-65 - RtBrick-QoS-Policer

The RtBrick-QoS-Policer value is a string which contains a list of multiple policer level settings separated by semicolon. Each setting contains a level, cir, cbs, pir, pbs, max-cir and max-pir separated by comma.

RtBrick-QoS-Policer = <level>,<cir>,<cbs>,<pir>,<pbs>,<max-cir>,<max-pir>;<level>...

Example:
RtBrick-QoS-Policer = 1,2000,200;2,8000,800;3,0,800;4,0,800

- **level**: 1 (highest priority) to 4 (lowest priority)
- **cir**: Ingress policer committed information rate (kbps)
- **cbs**: Ingress policer committed burst size (kbits)
- **pir**: Ingress policer peak information rate (kbps)
- **pbs**: Ingress policer peak burst size (kbits)
- **max-cir**: max ingress policer committed information rate (kbps)
- **max-pir**: max ingress policer peak information rate (kbps)

If PIR and PBS are not defined, the values from CIR and CBS are used as PIR and PBS as well. The max CIR and max PIR attributes are optional default set to unlimited.

This attribute can be also used as a key-value list which is automatically recognized by RBFS.

RtBrick-QoS-Policer = level=<level>,cir=<cir>,cbs=<cbs>,pir=<pir>,pbs=<pbs>,max-cir=<max-cir>,max-pir=<max-pir>;...

Example:
RtBrick-QoS-Policer = level=4,cir=1m,cbs=256;cir=2m,cbs=512,level=3

This attribute is supported by RADIUS access-accept and CoA request.

Updating a single policer level via CoA does not require to include other levels meaning that only the levels included in the attribute will be updated and all other levels remain unchanged. It is only possible to update existing policer levels dynamically but it is not possible to create a new level via RADIUS.

Assume the following example which adapts the just one level as well as all levels of a subscriber.

```
supervisor@rtbrick: op> show config forwarding-options class-of-service policer
policer-residential
{
  "rtbrick-config:policer": {
    "policer-name": "policer-residential",
    "level1-rates": {
      "cir": 1000,
      "cbs": 100,
      "pir": 1000,
      "pbs": 100
    },
    "level2-rates": {
      "cir": 4000,
      "cbs": 400,
      "pir": 4000,
      "pbs": 400
    },
    "level3-rates": {
      "cir": 0,
      "cbs": 800,
      "pir": 0,
      "pbs": 800
    },
    "level4-rates": {
      "cir": 0,
      "cbs": 800,
      "pir": 0,
      "pbs": 800
    },
    "levels": 4,
    "type": "two-rate-three-color"
  }
}
```

RADIUS VSA Change Level 2 Only

```
RtBrick-QoS-Policer: 2,12000,1200
```

RADIUS VSA Change all Levels

```
RtBrick-QoS-Policer: 1,2000,200;2,8000,800;3,0,800;4,0,800
```

All active dynamic policer level settings are stored in the table **global.access.1.subscriber.qos** to handover those information to forwarding infrastructure. This table can be also used to verify the dynamic policer settings for a given subscriber.

The CLI command show subscriber <id> qos displays those information in a nice human readable format.

```
supervisor@rtbrick: op> show subscriber 72339069014638610 qos
Subscriber-Id: 72339069014638610
    Interface: ifp-0/0/1
    Outer VLAN: 128
    Inner VLAN: 7
    IFL: ppp-0/0/1/72339069014638610
    Profile: qos_profile
    Parent: pon1
    Dynamic Ingress Policer Level 1:
        CIR: 2000 kbps CBS: 200 kbps
        PIR: 2000 kbps PBS: 200 kbps
    Dynamic Ingress Policer Level 2:
        CIR: 8000 kbps CBS: 800 kbps
        PIR: 8000 kbps PBS: 800 kbps
    Dynamic Ingress Policer Level 3:
        CIR: 0 kbps CBS: 800 kbps
        PIR: 0 kbps PBS: 800 kbps
    Dynamic Ingress Policer Level 4:
        CIR: 0 kbps CBS: 800 kbps
        PIR: 0 kbps PBS: 800 kbps
    Dynamic Shaper: shaper_voice
        Rate Low: 0 kbps
        Rate High: 2000 kbps
    Dynamic Shaper: shaper_session
        Rate Low: 2000 kbps
        Rate High: 14000 kbps
```

RADIUS QoS MFC

VSA 26-50058-66 - RtBrick-QoS-MFC

The multifield classifier can be either derived from qos-profile or directly using this attribute which has priority of the qos-profile.

```
RtBrick-QoS-MFC = <mfc-name>
```

This attribute is supported by RADIUS access-accept and CoA request.

The subscriber management infrastructure does not check if a referenced multifield classifier exists or not. This is handled by forwarding infrastructure which continues processing the subscriber QoS settings as soon as the classifier was added.

The string received in these attributes should be stored as mf_classifier_name in the RADIUS attribute object and as well as in the corresponding subscriber-qos object.

RADIUS QoS Queues

VSA 26-50058-67 - RtBrick-QoS-Queues

Subscribers can be associated with a QoS profile which is assigned via service-profile or directly via corresponding VSA (RtBrick-QoS-Profile). This profile is used to instantiate the QoS resources for the subscriber including schedulers, queues and shapers. The assigned queue instances can be updated using the RtBrick-QoS-Queues VSA (attribute 26-50058-67) which will apply to the QoS instance of the corresponding subscriber only, but not to the other subscribers using the same QoS profile. It is only possible to update existing queues dynamically but it is not possible to add queues via RADIUS.

The RtBrick-QoS-Queues value is a string which contains a list of multiple queue settings separated by semicolon. Each queue setting contains a queue name and queue size in bytes separated by comma.

```
RtBrick-QoS-Queues = <queue-name>,<size-bytes>;<queue-name>,<size-bytes>;...
```

This attribute can be also used as a key-value list which is automatically recognized by RBFS.

```
RtBrick-QoS-Queues = name=<queue-name>,size=<size-bytes>;name=...
```

This attribute is supported by RADIUS access-accept and CoA request.

Updating a single queue (e.g. best-effort) via CoA does not require to include other queues meaning that only the queues included in the attribute will be updated and

all other queues remain unchanged.

The subscriber management infrastructure does not check if a referenced queue exists or not. This is handled by forwarding infrastructure which continues processing the subscriber QoS settings as soon as the queue was added.

All active dynamic queues are stored in the table **global.access.1.subscriber.qos.queue** to handover those information to forwarding infrastructure. This table can be also used to verify the dynamic queues which are active for a given subscriber.

The CLI command show subscriber <id> qos displays those information in a nice human readable format.

```
supervisor@rtbrick: op> show subscriber 72339069014638610 qos
Subscriber-Id: 72339069014638610
    Interface: ifp-0/0/1
    Outer VLAN: 128
    Inner VLAN: 7
    IFL: ppp-0/0/1/72339069014638610
    Profile: qos_profile
    Parent: pon1
    Dynamic Ingress Policer Level 1:
        CIR: 2000 kbps CBS: 200 kbps
        PIR: 2000 kbps PBS: 200 kbps
    Dynamic Ingress Policer Level 2:
        CIR: 8000 kbps CBS: 800 kbps
        PIR: 8000 kbps PBS: 800 kbps
    Dynamic Ingress Policer Level 3:
        CIR: 0 kbps CBS: 800 kbps
        PIR: 0 kbps PBS: 800 kbps
    Dynamic Ingress Policer Level 4:
        CIR: 0 kbps CBS: 800 kbps
        PIR: 0 kbps PBS: 800 kbps
    Dynamic Shaper: shaper_voice
        Rate Low: 0 kbps
        Rate High: 2000 kbps
    Dynamic Shaper: shaper_session
        Rate Low: 2000 kbps
        Rate High: 14000 kbps
    Dynamic Queue: voice
        Size: 200000 byte
```

RADIUS IGMP Attributes

IGMP service can be dynamically enabled on a subscriber using Radius IGMP Attributes. These attributes are supported by RADIUS access-accept and CoA requests.

Following IGMP related attributes are supported:

VSA 26-50058-71 - RtBrick-IGMP-Status

This attribute can dynamically enable/disable IGMP for a subscriber

Value	Code	Description
DISABLED	0	Disable IGMP
ENABLED	1	Enable IGMP

VSA 26-50058-72 - RtBrick-IGMP-Profile

RtBrick-IGMP-Profile = <igmp-profile>

This attribute specifies the IGMP-profile to be associated with the subscriber. IGMP profile is configured locally in IGMP with all the IGMP related attributes. This attribute can dynamically associate such a locally configured profile to a subscriber

The subscriber management infrastructure does not check if a referenced IGMP profile exists or not. This is handled by IGMP infrastructure which continues processing the subscriber IGMP settings as soon as the profile was added.

VSA 26-50058-73 - RtBrick-IGMP-Version

This attribute can specify the version of IGMP for a subscriber.

Value	Code	Description
V1	1	IGMP Version 1 (not supported)
V2	2	IGMP Version 2
V3	3	IGMP Version 3 (Default version if this attribute is not set)

VSA 26-50058-74 - RtBrick-IGMP-Max-Members

This integer attribute can specify the number of parallel streaming (maximum IGMP membership) for a subscriber.

The CLI command show subscriber <id> igmp displays those information.

```
supervisor@rtbrick: op> show subscriber 72339069014638706 igmp
Subscriber-Id: 72339069014638706
    Interface: ifp-0/0/1
    Outer VLAN: 128
    Inner VLAN: 7
    IFL: ppp-0/0/3/72339069014638706
    State: active
    Version: IGMPv3
    Profile: iptv-basic
    Max Members: 6
```

The states are active, inactive and disabled. The state is inactive if IGMP is enabled but the IPv4 protocol state is not active.

RADIUS Connection Status Message Attribute

VSA 26-50058-139 - RtBrick-Connection-Status-Message

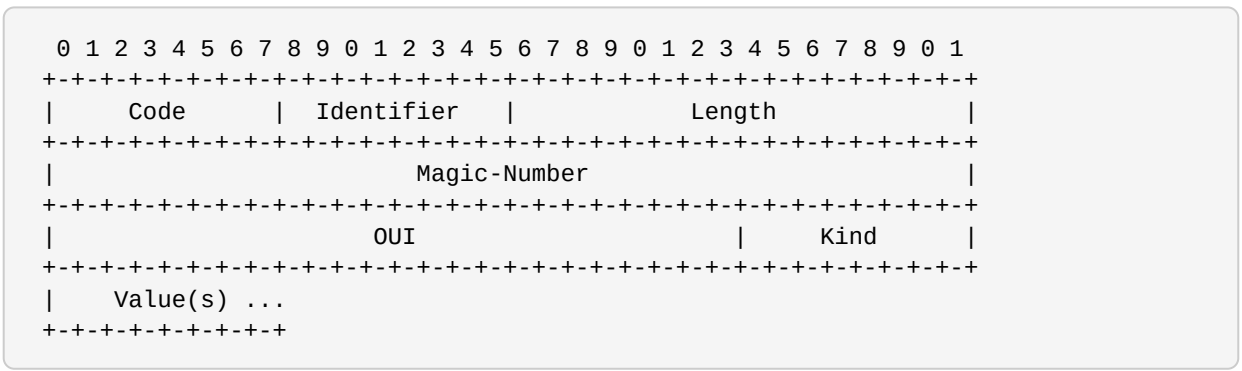
This attribute allows to send a connection status message string via PPP LCP vendor extension (RFC2513) to the client.

The connection status message is typically used to inform clients about the available bandwidth via RADIUS access-accept or CoA request.

```
RtBrick-Connection-Status-Message = <string>
```

Adding or changing the connection status message triggers to send a LCP vendor specific packet with OUI set to f4:1e:5e (RtBrick Inc.) and kind 0x01.

RFC 2513 - Vendor Specific Packet



The value is encoded as TLV with type set to 0x01 and length including type and length field.

The actual status message string is limited to 247 bytes.

Connection-Status-Message Option

```
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|     Type      |    Length     | Connection-Status-Message     |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| ...
+-+-+
```

PPP clients with support for connection status message will respond with a vendor specific packet of kind 0x02 and the same OUI but no value to acknowledge the packet. All other clients either ignore or reject the message using PPP LCP code reject.

The connection status message will be retried 10 times with an interval of 3 seconds until the client has acknowledged or rejected the packet.

The status of the connection status message can be verified with the following command.

```
supervisor@leaf1: op> show pppoe session 72339069014638706 detail
Subscriber-Id: 72339069014638706
    State: ESTABLISHED
    Uptime: Mon Sep 13 09:29:42 GMT +0000 2021 (0:14:57.625027)
    Interface: ifp-0/0/1
    Outer VLAN: 128
    Inner VLAN: 7
...
    PPP LCP:
        State: OPENED
        Negotiated Protocols: PAP, IPCP, IP6CP
        Negotiated Parameters: MRU, AUTH, MAGIC
        Magic Number: 130827225 Peer: 2835676915
        MRU: 1492 Peer: 1492
        Echo Interval: 30 seconds
    PPP LCP Connection Status Message:
        State: ACCEPTED
        Message: SRU=10000#SRD=100000#
...
```

RADIUS Ascend-Data-Filter Attribute

VSA 26-529-242 - Ascend-Data-Filter

The Ascend-Data-Filter attribute describes per subscriber filter terms in a simple binary format as described in the following table. Multiple of those attributes in a

single RADIUS access-accept or CoA request message are combined to a dynamic filter where each attribute itself is one filter term. The order of those attributes in the RADIUS message is used to order the corresponding terms in the filter. This means that the first filter in the RADIUS packet has priority over the next and or last filter in the RADIUS packet.

Changes in such a filter via CoA requires that all attributes of the new filter must be sent. Therefore adding a single filter term requires sending the existing filter terms plus the new one or general speaking sending the intended target filter.

This filter is installed as a global packet filter placed before policer in ingress and before scheduler in egress to prevent that traffic dropped here is counted in accounting or consuming rate credits.

Field	Bytes	Values	Comments
Type	1	0 = ignore 1 = IPv4 3 = IPv6	
Action	1	0 = discard 1 = accept 0x20 = redirect	
Direction	1	0 = egress 1 = ingress	
Reserved	1	0	
Source Address	IPv4 = 4 IPv6 = 16	source address	Match on source address is not supported for filters in ingress direction and automatically replaced with the subscriber addresses.

Field	Bytes	Values	Comments
Destination Address	IPv4 = 4 IPv6 = 16	destination address	Match on destination address is not supported for filters in egress direction and automatically replaced with the subscriber addresses.
Source Prefix Length	1	0 = ignore prefix length	The number of leading one bits in the source address mask. Specifies the bits of interest.
Destination Prefix Length	1	0 = ignore prefix length	The number of leading one bits in the destination address mask. Specifies the bits of interest.
Protocol	1	0 = ignore IPv4 protocol number IPv6 next header	
Reserved	1	0	
Source Port	2	port number	UDP/TCP source port in network byte order (big endian)
Destination Port	2	port number	UDP/TCP destination port in network byte order (big endian)

Field	Bytes	Values	Comments
Source Port Qualifier	1	0 = no compare 1 = less than 2 = equal to 3 = greater than 4 = not equal to	The options 1, 3 and 4 are not implemented and mapped to 0 if received.
Destination Port Qualifier	1	0 = no compare 1 = less than 2 = equal to 3 = greater than 4 = not equal to	The options 1, 3 and 4 are not implemented and mapped to 0 if received.
Not Used	0 - N	0	Trailing bytes after destination port qualifier ignored.

The filter can be deleted dynamically by sending a single Ascend-Data-Filter attribute with a zero value.

Example:

```
Ascend-Data-Filter =
0x0100010000000000a0afffe00200000000000000000000000000000000

    01          IPv4            // type
    00          discard         // action
    01          ingress         // direction
    00          -               // reserved
    00000000    -               // source address
    0a0afffe    198.51.100.101  // destination address
    00          -               // source prefix length
    20          /32             // destination prefix length
    00          -               // protocol
    00          -               // reserved
    0000        -               // source port
    0000        -               // destination port
    00          -               // source port qualifier
    00          -               // destination port qualifier
    00000...    -               // ignored
```



For ingress filters, it is not permitted to match based on the source address which is automatically replaced with the subscriber addresses. A similar limitation is valid for egress filters matching on destination address which is also replaced with subscriber addresses.



A new proprietary filter action 0x20 (32) is added for the redirect service. This can be used to enable HTTP Redirect for a subscriber using the ADF.

All active subscriber filters are stored in the table **global.access.1.subscriber.filter** to hand over that information to the forwarding infrastructure. This table can be also used to verify the filters which are active for a given subscriber.

The CLI command show subscriber <id> acl displays those filters in a nice human-readable format.

RADIUS Access Line Attributes

The access line identification and characterization information are defined in the Broadband Forum (BBF) formerly known DSL Forum attributes including Agent-Remote-Id and Agent-Circuit-Id.

See the following references for more information about access line attributes.

- RFC 4679 DSL Forum Vendor-Specific RADIUS Attributes
- RFC 6320 ANCP
- Broadband Forum TR-101
- draft-lihawi-ancp-protocol-access-extension-04

Those attributes will be sent in RADIUS access and accounting requests to the RADIUS server if learned from the underlying access protocol like PPPoE (BBF TR-101).

RBFS also provides the possibility to set those values via RADIUS by using the same attributes in the RADIUS access-accept or CoA request message.

Access Line Attributes Supported (RADIUS, PPPoE and L2TP):

Attribute	Name
26-3561-1	Agent-Circuit-Id
26-3561-2	Agent-Remote-Id
26-3561-18	PON-Access-Line-Attributes
26-3561-129	Actual-Data-Rate-Upstream
26-3561-130	Actual-Data-Rate-Downstream
26-3561-131	Minimum-Data-Rate-Upstream
26-3561-132	Minimum-Data-Rate-Downstream
26-3561-133	Attainable-Data-Rate-Upstream
26-3561-134	Attainable-Data-Rate-Downstream
26-3561-135	Maximum-Data-Rate-Upstream
26-3561-136	Maximum-Data-Rate-Downstream
26-3561-137	Minimum-Data-Rate-Upstream-Low-Power
26-3561-138	Minimum-Data-Rate-Downstream-Low-Power
26-3561-139	Maximum-Interleaving-Delay-Upstream
26-3561-140	Actual-Interleaving-Delay-Upstream
26-3561-141	Maximum-Interleaving-Delay-Downstream
26-3561-142	Actual-Interleaving-Delay-Downstream
26-3561-144	Access-Loop-Encapsulation
26-3561-145	DSL-Type
26-3561-151	PON-Access-Type
26-3561-155	Expected-Throughput-Upstream
26-3561-156	Expected-Throughput-Downstream
26-3561-157	Attainable-Expected-Throughput-Upstream
26-3561-158	Attainable-Expected-Throughput-Downstream

Attribute	Name
26-3561-159	Gamma-Data-Rate-Upstream
26-3561-160	Gamma-Data-Rate-Downstream
26-3561-161	Attainable-Gamma-Data-Rate-Upstream
26-3561-162	Attainable-Gamma-Data-Rate-Downstream
26-3561-176	ONT-ONU-Average-Data-Rate-Downstream
26-3561-177	ONT-ONU-Peak-Data-Rate-Downstream
26-3561-178	ONT-ONU-Maximum-Data-Rate-Upstream
26-3561-179	ONT-ONU-Assured-Data-Rate-Upstream
26-3561-180	PON-Tree-Maximum-Data-Rate-Upstream
26-3561-181	PON-Tree-Maximum-Data-Rate-Downstream

This table includes already the new attributes defined in draft-lihawi-ancp-protocol-access-extension-04 which results in possible changes in case the draft is updated.

Changes in at least one of those line attributes via CoA trigger a RADIUS interim accounting request with the new values.

Changes in actual data rate upstream/downstream via CoA request may trigger the L2TP LAC to send a CSUN request with updated connection speed to the LNS depending on the actual L2TP configuration.

RADIUS L2TP

Tunneling of PPPoE sessions via L2TPv2 (L2TP LAC) is supported on RBFS and can be controlled via RADIUS as described in RFC 2868 RADIUS Attributes for Tunnel Protocol Support with some limitations:

- No support of FQDN format for IP addresses
- No support Tunnel-Medium-Type other than IPv4

To establish a PPPoE session via L2TP, the tunnel-type must be configured as L2TP. This configuration can be achieved either for local users or by utilizing the corresponding tunnel-type attribute through RADIUS.

Defining an L2TP configuration profile is essential, which can be referenced through an access configuration profile or by employing the appropriate RADIUS VSA. The actual tunnels may either be defined locally via an L2TP pool configuration or set up dynamically through RADIUS.

```
# FreeRADIUS
# RADIUS authenticated with local defined tunnels.
"radius@l2tp" Cleartext-Password := "test"
    Service-Type = Framed-User,
    Framed-Protocol = PPP,
    Tunnel-Type:0 = L2TP

# RADIUS authenticated with dynamic tunnels.
"tunnel@rl2tp" Cleartext-Password := "test"
    Service-Type = Framed-User,
    Framed-Protocol = PPP,
    Tunnel-Type:1 = L2TP,
    Tunnel-Client-Endpoint:1 = "192.0.2.1",
    Tunnel-Server-Endpoint:1 = "192.0.2.2",
    Tunnel-Client-Auth-Id:1 = "bng",
    Tunnel-Server-Auth-Id:1 = "lns",
    Tunnel-Preference:1 = 100,
    Tunnel-Password:1 = "test",
    Tunnel-Type:2 += L2TP,
    Tunnel-Client-Endpoint:2 += "192.0.2.3",
    Tunnel-Server-Endpoint:2 += "192.0.2.4",
    Tunnel-Client-Auth-Id:2 += "BNG",
    Tunnel-Server-Auth-Id:2 += "LNS2",
    Tunnel-Preference:2 += 200,
    Tunnel-Password:2 += "test"
```

In addition to the standard attributes, the following vendor-specific attributes are supported for L2TP.



RFC and draft compliance are partial except as specified.

VSA 26-50058-40 - RtBrick-L2TP-Pool

Instead of RADIUS tunnel attributes it is also possible to configure local L2TP tunnel pools and assign them with this attribute.

VSA 26-50058-41 - RtBrick-L2TP-Profile

The default L2TP configuration profile assigned in the access configuration profile can be changed in RADIUS access-accept to allow different L2TP configurations

based on tunnel endpoints. This is typically used to enable or disable L2TP CSUN updates (RFC5515).

VSA 26-50058-42 - RtBrick-L2TP-Tx-Connect-Speed

VSA 26-50058-43 - RtBrick-L2TP-Rx-Connect-Speed

These attributes are supported in RADIUS access-accept and CoA requests to set the corresponding L2TP to connect speed values directly. Per default, the L2TP connect speed is derived from the actual data rate upstream/downstream of the configured source (PPPoE-IA or RADIUS) if present or set to port speed which can be overridden with the connect speed attributes. Changes in connect speed via CoA request will trigger the L2TP LAC to send a CSUN request to the LNS if enabled.

These two attributes are defined as 4-byte integers with speed defined in bits per second (bps).

RADIUS Lawful Interception

Lawful interception (LI) refers to the facilities in telecommunications and telephone networks that allow law enforcement agencies (LEA) with court orders or other legal authorization to selectively intercept individual subscribers. The term mediation device (MED) used in this document describes the element which receives and optionally converts the intercepted traffic into the format expected by the law enforcement agencies of the corresponding countries.

All of the following attributes must be present in RADIUS access-accept or CoA request to control lawful interception (LI) via RADIUS. Those attributes are salt encrypted using the algorithm described in RFC 2868 for the Tunnel Password. This encryption algorithm is defined for RADIUS access-accept messages only. To support CoA requests the request authenticator should be replaced with 16 zero bytes which is common industry standard.

The LI action NOOP can be used to obfuscate lawful interception requests (fake requests) to prevent just the presence of those attributes indicating that a subscriber is intercepted. LI requests via RADIUS will show up in the same table as requests via REST or HTTP RPC API (global.access.1.li_request).



Failed LI activations are not signaled via RADIUS to prevent that just the presence of CoA response NAK shows that LI request is

not fake (action NOOP).

VSA 26-50058-140 - RtBrick-LI-Action (salt encrypted integer)

Value	Code	Description
NOOP	0	No action / Ignore LI request
ON	1	Start LI / Add LI request
OFF	2	Stop LI / Delete LI request

VSA 26-50058-141 - RtBrick-LI-Identifier (salt encrypted integer)

Device unique lawful interception identifier (LIID) within the range from 1 to 4194303.

VSA 26-50058-142 - RtBrick-LI-Direction (salt encrypted integer)

Value	Code	Description
INGRESS	1	Ingress mirroring only (from subscriber)
EGRESS	2	Egress mirroring only (to subscriber)
BOTH	3	Bidirectional mirroring (from and to subscriber)

VSA 26-50058-143 - RtBrick-LI-MED-Instance (salt encrypted string)

Routing instance through which the mediation device is reachable.

VSA 26-50058-144 - RtBrick-LI-MED-IP (salt encrypted IPv4 address)

IPv4 address of the mediation device.

VSA 26-50058-145 - RtBrick-LI-MED-Port (salt encrypted integer)

UDP port between 49152 and 65535 are set in the mirrored traffic.

RADIUS Framed Routes

The framed-route attributes are used by the RADIUS to install specific routes for a given subscriber. The corresponding next-hop information is automatically derived from the subscriber context. This functionality is typically used to route additional customer networks through the client device (CPE).

Those attributes are supported via RADIUS access-accept only. Each of those attributes may occur multiple times to install various routes. The actual amount of routes supported is limited by the maximum RADIUS packet size only.

The framed-route attributes are defined in RFC 2865 for IPv4 and RFC 3162 for IPv6 but the actual content of those attributes is implementation dependent. RBFS is expecting a string with a prefix followed by prefix length. The prefix can be followed by further routing options like costs, metric or even next-hop which are currently ignored.

Attribute 22 - Framed-Route

```
Framed-Route = "198.51.100.69/24"
```

Attribute 99 - Framed-IPv6-Route

```
Framed-IPv6-Route = "2001:db8:0:90::/32"
```

RADIUS Subscriber ACLs (Filters)

The subscriber ACL attributes are used by the RADIUS server to install a specific ACL, which has already been configured in the BNG, for a subscriber. For information about Subscriber ACL Configuration see 'Subscriber ACLs and HTTP Redirect Service' guide. After the Subscriber ACLs are configured with the name and the rules, use the following RADIUS attributes dynamically for adding or changing those ACLs from RADIUS. These attributes are supported in access-accept and CoA.

The subscriber ACL attributes are used by the RADIUS server to install a specific ACL, which has already been configured in the BNG, for a subscriber. For information about Subscriber ACL Configuration, see the 'Subscriber ACLs and HTTP Redirect Service' guide. After the Subscriber ACLs are configured with the name and the rules, use the following RADIUS attributes to add or change those

ACLs from RADIUS. These attributes are supported in access-accept and CoA.

When a CoA is issued with one of those ACL attributes or a service profile, it will always reset all existing filters, even if the new service profile does not define any filters. If there are filters specified within the service profile along with subscriber ACL attributes, these subscriber ACL attributes take precedence. The filters are merged by first applying all the filters from the service profile and then adding or replacing filters using the attributes defined here. The final resulting filter set is then applied to the subscriber.

Filters that were applied first but are not defined in the new set will be deleted. Consequently, adding a single filter via CoA will remove all other existing filters. This approach is designed to provide a more declarative way of defining the desired target state without depending on the existing state.

- ***VSA 26-50058-76 - RtBrick-IPv4-ACL-In***

```
Attach IPv4 subscriber ingress ACL (ACL in upstream direction)
```

- ***VSA 26-50058-77 - RtBrick-IPv4-ACL-Out***

```
Attach IPv4 subscriber ingress ACL (ACL in downstream direction)
```

- ***VSA 26-50058-78 - RtBrick-IPv6-ACL-In***

```
Attach IPv6 subscriber ingress ACL (ACL in upstream direction)
```

- ***VSA 26-50058-79 - RtBrick-IPv6-ACL-Out***

```
Attach IPv6 subscriber egress ACL (ACL in downstream direction)
```

Example:

RtBrick-IPv4-ACL-In = “ipoe-sub1-http-acl“

To detach any of the preceding ACLs and to delete the ACL associated with a subscriber, null string can be used with the corresponding attribute.

Example:

RtBrick-IPv4-ACL-In = “”

RADIUS HTTP Redirect URL

When HTTP Redirect is enabled for a subscriber either through Ascend-Data-Filter or through the subscriber ACLs, HTTP packets from the subscriber get redirected to the URL set by this attribute:

VSA 26-50058-75 - RtBrick-HTTP-Redirect-URL

This attribute is supported on RADIUS access-accept and CoA requests. This attribute allows the overwriting of the URL.

For example:

RtBrick-HTTP-Redirect-URL = “http://portal.rtbrick.com”

To reset the URL:

RtBrick-HTTP-Redirect-URL = “”

RADIUS Sourced DHCP Options

RBFS allows for centralized configuration of DHCP options directly on a RADIUS server, enabling dynamic distribution of these options on a per-subscriber basis. This approach, known as **RADIUS Sourced DHCP Options**, shifts the responsibility of defining and managing DHCP options to the RADIUS server.

Since RBFS performs minimal processing and validation on these options, they are treated as **raw data**, meaning they are forwarded without modification or extensive error checking.

- ***VSA 26-50058-30 - RtBrick-DHCPv4-Client-Options***
- ***VSA 26-50058-32 - RtBrick-DHCPv6-Client-Options***

The client-option attributes allow DHCP options to be included as part of the Access-Accept message. These options are then inserted into outgoing packets directed toward the subscribers DHCP client, regardless of whether RBFS is operating in IPoE relay/proxy mode or server mode.

- ***VSA 26-50058-31 - RtBrick-DHCPv4-Server-Options***
- ***VSA 26-50058-33 - RtBrick-DHCPv6-Server-Options***

Unlike client-option attributes, the server-option attributes are only supported in IPoE relay/proxy mode and are specifically designed to modify packets being forwarded to a DHCP server. This functionality provides additional configuration flexibility when RBFS operates as a relay or proxy between the client and the DHCP server.

For example, server-option attributes can be used to insert specific DHCP options into requests sent to the DHCP server, enabling it to select the appropriate IP address pool based on the provided parameters.

If a RADIUS server includes multiple instances of the same DHCP option within a single Access-Accept message, RBFS will concatenate them into a single data stream. However, the order of the attributes in the packet is crucial for proper reassembly.

For successful concatenation, the option instances must appear consecutively in the RADIUS response. If other attributes are interleaved between multiple instances of **RtBrick-DHCP-Client-Options**, those can't be concatenated.

FreeRADIUS Example:

```
"02:00:00:00:00:01@ipoe" Cleartext-Password := "ipoe"
    Service-Type = Framed-User,
    Class = IPOE,
    RtBrick-DHCPv4-Client-Options = "0x39020240",
    RtBrick-DHCPv4-Client-Options += "0x3d0701001094000008",
    RtBrick-DHCPv4-Server-Options = "0x39020240",
    RtBrick-DHCPv6-Server-Options = "0x001100100000c38a000200084353522D56365044",
    RtBrick-DHCPv6-Client-Options = "0x001100100000c38a000100084353522D56365044"
```

Example Option:

```
0x39020240

  39    Code      // DHCP Max Msg Size
  02    Length    // 2 Byte
  0240  Data      // 576 Byte
```



Since options are added as raw data, they must be in network byte order.

DHCPv6 and DHCPv4 operate differently when it comes to the inclusion of client and server options within DHCP messages.

In DHCPv6, server options are incorporated into the outermost DHCPv6 relay header. This specific header is added by the relay agent (RBFS). On the other hand, client options are added to the innermost DHCPv6 message, but this only occurs if the message type is either an advertisement (type 2) or a reply (type 7).

Conversely, in DHCPv4, the placement of client and server options is based on specific message types. Client options are exclusively added to offer (type 2) and ack (type 5) messages. In contrast, server options are only included in discovery (type 1) and request (type 3) messages.

The following DHCP options are not permitted and will be filtered out if attempted to be added via RADIUS:

DHCPv4:

- **0:** Pad Option
- **51:** IP Address Lease Time
- **52:** Option Overload
- **53:** DHCP Message Type
- **54:** Server Identifier
- **55:** Parameter Request List
- **255:** End

DHCPv6:

- **1:** OPTION_CLIENTID
- **2:** OPTION_SERVERID
- **3:** OPTION_IA_NA
- **6:** OPTION_ORO
- **8:** OPTION_ELAPSED_TIME
- **25:** OPTION_IA_PD

The DHCP options will add received options even if they are already present in the original packet unless they are filtered out as not allowed or invalid. For the

DHCPv4 server options listed below, the original option is removed before the same option is added via the DHCPv4 server options to prevent duplicate options. Other options may still become duplicates.

- Client-Identifier (61)
- Relay-Agent (82)

RADIUS Terminate Codes

VSA 26-50058-27 - RtBrick-Terminate-Code

The RtBrick-Terminate-Code is sent along with the standard Acct-Terminate-Cause (attribute 49). The list below shows the RtBrick termination codes with the mapping to the standard cause.

RtBrick-Terminate-Code	Acct-Terminate-Cause (RADIUS Attribute 49)	Description
0	10 (NAS Request)	NA
1	10 (NAS Request)	Subscriber Management Unknown Error
2	9 (NAS Error)	SubscriberD Internal Error
3	9 (NAS Error)	PPPoED Internal Error
4	9 (NAS Error)	PPPoED Object Deleted *This code is used if an PPPoE session object is deleted which is an indication for a crash or some other issues in PPPoE daemon.*
5	9 (NAS Error)	L2TPD Internal Error
6	9 (NAS Error)	L2TPD Object Deleted *This code is used if an L2TP session object is deleted which is an indication for a crash or some other issues in L2TP daemon.*
7	9 (NAS Error)	AAA Profile Not Found

RtBrick-Terminate-Code	Acct-Terminate-Cause (RADIUS Attribute 49)	Description
8	9 (NAS Error)	RADIUS Profile Not Found
9	9 (NAS Error)	Authentication Type Missing
10	9 (NAS Error)	Authentication Order Missing or Invalid
11	10 (NAS Request)	Authentication Failure
12	10 (NAS Request)	Local Authentication Failed
13	10 (NAS Request)	Accounting-Request-On Wait
14	9 (NAS Error)	No RADIUS Authentication Server Configured
15	10 (NAS Request)	RADIUS Authentication Failed
16	17 (User Error)	Authentication Rejected
17	17 (User Error)	Local Authentication Rejected
18	17 (User Error)	RADIUS Authentication Rejected
19	5 (Session Timeout)	Session Timeout
20	4 (Idle Timeout)	Idle Timeout
21	6 (Admin Reset)	Clear Session
22	6 (Admin Reset)	RADIUS CoA Disconnect
23	9 (NAS Error)	PPPoE Unknown Error
24	1 (User Request)	PPPoE PADT Received
25	9 (NAS Error)	PPPoE LCP Error
26	10 (NAS Request)	PPPoE LCP Generic Error
27	1 (User Request)	PPPoE LCP Terminate Request Received
28	10 (NAS Request)	PPPoE LCP Maximum Reject / NAK Exceeded
29	10 (NAS Request)	PPPoE LCP Negotiation Failed
30	10 (NAS Request)	PPPoE LCP Configuration-Request Exceeded

RtBrick-Terminate-Code	Acct-Terminate-Cause (RADIUS Attribute 49)	Description
31	10 (NAS Request)	PPPoE LCP Echo-Request Timeout Exceeded
32	9 (NAS Error)	PPPoE PAP Error
33	9 (NAS Error)	PPPoE CHAP Error
34	9 (NAS Error)	PPPoE IPCP Error
35	9 (NAS Error)	PPPoE IP6CP Error
36	9 (NAS Error)	PPPoE NCP Initialization Failed
37	10 (NAS Request)	PPPoE NCP Down
38	6 (Admin Reset)	PPPoE Clear Session
39	10 (NAS Request)	PPPoE Upper Layer Down
40	8 (Port Error)	PPPoE Interface Down
41	10 (NAS Request)	PPPoE Configuration Deleted
42	9 (NAS Error)	PPPoE Access Configuration Profile Not Found
43	9 (NAS Error)	L2TP Unknown Error
44	10 (NAS Request)	L2TP Tunnel Down
45	10 (NAS Request)	L2TP Tunnel Dead
46	10 (NAS Request)	L2TP Tunnel Deleted
47	10 (NAS Request)	L2TP No Tunnel Available
48	10 (NAS Request)	L2TP CDN Request
49	9 (NAS Error)	L2TP Profile Not Found
50	9 (NAS Error)	L2TP Access Configuration Profile Not Found
51	9 (NAS Error)	L2TP No Tunnel Pool Error
52	9 (NAS Error)	L2TP Local Tunnel Pool Error
53	9 (NAS Error)	L2TP RADIUS Tunnel Pool Error
54	6 (Admin Reset)	L2TP Clear Session

RtBrick-Terminate-Code	Acct-Terminate-Cause (RADIUS Attribute 49)	Description
55	9 (NAS Error)	Access Configuration Profile Not Found
56	9 (NAS Error)	Local IPv4 Address Pool Not Found
57	10 (NAS Request)	Local IPv4 Address Pool Exhausted
58	9 (NAS Error)	Local IPv6 Prefix Pool Not Found
59	10 (NAS Request)	Local IPv6 Prefix Pool Exhausted
60	9 (NAS Error)	Local IPv6 Delegated Prefix Pool Not Found
61	10 (NAS Request)	Local IPv6 Delegated Prefix Pool Exhausted
62	10 (NAS Request)	PPPoE CHAP Response Timeout
63	10 (NAS Request)	L2TP Session Deleted
64	10 (NAS Request)	Duplicate IPv4 address detected
65	10 (NAS Request)	Duplicate IPv6 prefix detected
66	10 (NAS Request)	Duplicate delegated IPv6 prefix detected
67	9 (NAS Error)	Routing instance not found
68	6 (Admin Reset)	Clear Session Force
69	6 (Admin Reset)	Test AAA Request Object Deleted

RtBrick-Terminate-Code	Acct-Terminate-Cause (RADIUS Attribute 49)	Description
70	9 (NAS Error)	IPoED Object Deleted *This code is used if an IPoE subscriber object is deleted which is an indication for a crash or some other issues in IPoE daemon.*
71	9 (NAS Error)	IPoED Internal Error
72	9 (NAS Error)	IPoE Unknown Error
73	10 (NAS Request)	IPoE Upper Layer Down
74	10 (NAS Request)	IPoE Lower Layer Down
75	10 (NAS Request)	IPoE Interface Down
76	10 (NAS Request)	IPoE Configuration Deleted
77	10 (NAS Request)	SubscriberD Request
78	10 (NAS Request)	L2BSA Service Deleted
79	10 (NAS Request)	L2BSA Service Added
80	6 (Admin Reset)	IPoE Clear Subscriber
81	6 (Admin Reset)	PPPoE Clear Session Force
82	9 (NAS Error)	IPoE Invalid Gateway IFL
83	9 (NAS Error)	FWD Invalid
84	9 (NAS Error)	FWD Failed
85	9 (NAS Error)	FWD Deleted
86	10 (NAS Request)	Instance Deleted
87	10 (NAS Request)	Redundancy Switchover
88	10 (NAS Request)	Redundancy Active Node Termination
89	10 (NAS Request)	Redundancy Active Node Down
90	9 (NAS Error)	Redundancy Invalid State
91	9 (NAS Error)	Redundancy Invalid State for Sync

RtBrick-Terminate-Code	Acct-Terminate-Cause (RADIUS Attribute 49)	Description
92	9 (NAS Error)	Redundancy Validation Failed
93	10 (NAS Request)	Redundancy Config Deleted
94	9 (NAS Error)	Redundancy Stale Timer Expiry
95	9 (NAS Error)	IPv4 In ACL Validation Failed
96	9 (NAS Error)	IPv4 Out ACL Validation Failed
97	9 (NAS Error)	IPv6 In ACL Validation Failed
98	9 (NAS Error)	IPv6 Out ACL Validation Failed
99	9 (NAS Error)	IP Address Allocation Failed
100	9 (NAS Error)	No IP Address
101	6 (Admin Reset)	Subscriber Deleted
102	10 (NAS Request)	Redundancy No Interface To Assign *This code is used if a forwarding subscriber object is deleted which is an indication of a crash or some other issues in the forwarding infrastructure.*
103	10 (NAS Request)	IPoE DHCPv4 Released
104	10 (NAS Request)	IPoE DHCPv4 Expired
105	10 (NAS Request)	IPoE DHCPv4 Failed
106	10 (NAS Request)	IPoE DHCPv6 Released
107	10 (NAS Request)	IPoE DHCPv6 Expired
108	10 (NAS Request)	IPoE DHCPv6 Failed
109	10 (NAS Request)	IPoE DHCPv4 Released DHCPv6 Released
110	10 (NAS Request)	IPoE DHCPv4 Released DHCPv6 Expired
111	10 (NAS Request)	IPoE DHCPv4 Released DHCPv6 Failed

RtBrick-Terminate-Code	Acct-Terminate-Cause (RADIUS Attribute 49)	Description
112	10 (NAS Request)	IPoE DHCPv4 Expired DHCPv6 Released
113	10 (NAS Request)	IPoE DHCPv4 Expired DHCPv6 Expired
114	10 (NAS Request)	IPoE DHCPv4 Expired DHCPv6 Failed
115	10 (NAS Request)	IPoE DHCPv4 Failed DHCPv6 Released
116	10 (NAS Request)	IPoE DHCPv4 Failed DHCPv6 Expired
117	10 (NAS Request)	IPoE DHCPv4 Failed DHCPv6 Failed
118	10 (NAS Request)	Invalid RADIUS Authentication Response
119	10 (NAS Request)	PPPoE and IPoE on same VLAN not Supported

It is recommended to raise operational alarms for every termination cause received with a value of 9 (NAS Error) for further investigations.

RADIUS CoA Error Handling

CoA requests should be retried a few times in the unlikely event of CoA NAK with error-cause (RFC 5176 attribute 101) other than session-context-not-found (503) or missing-attribute (402). There is no rollback of failed CoA requests to the former state but retrying the same request is supported because changes are implemented in a more declarative way.

5.2.4. RADIUS Accounting

RADIUS accounting servers handle accounting records for subscribers. The subscriber daemon transmits RADIUS Accounting-Start, Interim and Stop messages to these servers. Accounting is the process of tracking subscriber activity and network resource usage in a subscriber session. This includes the session time

called time accounting and the number of packets and bytes transmitted during the session called volume accounting.

A RADIUS Acct-Status-Type attribute is used by the RADIUS client (subscriber daemon) to mark the start of accounting (for example, upon booting) by specifying Accounting-On and to mark the end of accounting (for example, just before a scheduled reboot) by specifying Accounting-Off. This message is often used by RADIUS servers to automatically close/terminate all open accounting records/sessions for the corresponding client and therefore must not be sent to servers belonging to a profile which was already used/started for accounting.

Per default, the assumption is that all servers referenced by a RADIUS profile share the same states and therefore accounting-on must be only sent to one of those before the first accounting-start is sent.

RADIUS Accounting-On/Off messages are disabled by default and can be optionally enabled in the RADIUS profile configuration. There is also an additional configuration option to optionally wait for Accounting-On response which prevents any new session until accounting has started meaning that Accounting-On response is received.



Accounting-Off is currently not implemented!

RADIUS accounting requests are often used for billing and therefore should be able to store and retry over a longer period (common up to 24 hours or more) which can be optionally enabled in the RADIUS profile configuration using the accounting backup configuration option.

Time Accounting

All accounting relevant timestamps are retrieved using the UNIX system call clock_gettime internally stored in the datastore as 64 bit microseconds timestamp with the lower order 32 bit representing the seconds since January 1, 1970 00:00 UTC which is also known as epoch or unix timestamp and the higher order 32 bit representing the microseconds which are per definition less than 1.000.000 (one second). The seconds part is counted in full seconds which is similar to always rounded down.

The RADIUS attribute event-timestamp (type 55) defined in RFC2869 is included in each RADIUS Accounting-Request packet to record the time that this event occurred in seconds since January 1, 1970 00:00 UTC. A max allowed deviation of

500 milliseconds of a timestamp in seconds requires mathematical rounding of the internal 64 bit microseconds timestamps to the 32 bit RADIUS event-timestamp in seconds. This means to round down if the microseconds part of the timestamp is less than 0.5 seconds and rounded up if equal or greater than 0.5 seconds.

Start Timestamps

In RBFS the timestamp indicating the PPPoE session start will be generated after successful negotiation of at least one of the PPP network control protocols (IPCP for IPv4 or IP6CP for IPv6). In case of L2TP tunneled sessions (LAC), the successful L2TP session setup after sending ICCN is used as a start timestamp. In both cases this is also the trigger for the RADIUS accounting-request start where this timestamp is used as RADIUS event-timestamp.

Stop Timestamps

The timestamp indicating the session stop will be generated more or less immediately after termination request (e.g. timeout, user request, nas request, ...).

The RADIUS attribute Acct-Session-Time (type 46) defined in RFC2866 indicates how many seconds the user has received service and can only be present in Accounting-Request records where the Acct-Status-Type is set to Interim or Stop. This time will be calculated based on the internal session start and stop time in microseconds and mathematical rounded to seconds. For RADIUS accounting interim requests the current event time is used instead of stop time.



RFC and draft compliance are partial except as specified.

Volume Accounting

Based on §45g of the German Telecommunications Act (TKG), the maximum deviation for accounting relevant counters must be less than 1% per billing period which is typically one month.

The whole RBFS architecture is based on an event-based publish and subscribe model using the BDS infrastructure. Each process publishes all information and states to BDS and interested processes subscribe to that information. The whole inter process communications (IPC) is replaced by BDS table operations which allows to build a hyper scaled distributed software system. This means related to accounting that each counter is requested from data plane and updated in BDS unsolicited based on configurable intervals typically set between 5 to 30 seconds.

This applies to any type of counters like interface counters or QoS statistics. This means that CLI commands or API requests will return the last updated counter and not the counter of the time of request. Therefore each BDS object contains a timestamp indicating the time of the last counter update which allows to use these counters with the required accuracy.

Subscriber volume accounting is based on multiple sources like logical interface (LIF), class/queue-, policer- and control-traffic statistics.

All those counters are layer 2 (L2) counters and some of them may reset through configuration changes like QoS counters after applying a new QoS profile. Therefore the subscriber management application daemon is doing some post processing of all counters to ensure that no accounting information is lost and to calculate the final accounting values. This includes also optional configurable counter adjustments.

There is a BDS database object in the table **local.access.subscriber.accounting** created for each subscriber which stores all counters and attributes required to calculate the actual volume counters. This object is created together with the subscriber and automatically deleted if the actual subscriber object is removed.

The volume accounting counters must not reset if the actual hardware counter is deleted or has changed/reset to zero. Therefore instead of using the source counter directly, the delta since the last interval is calculated and added to the final counter.

The usage of callback functions to counter delete and change events ensures that no accounting relevant information will be lost through reconfiguration of subscriber sessions.

The function which removes the subscriber counters from the data plane will receive the final counters before removal and update them into BDS counter objects before this is deleted.

Interims Volume Counters

RADIUS accounting interim requests will also use the last updated counters with current time as event-timestamp.

Stop Volume Counters

The session termination might be triggered by REST API, CLI (clear subscriber ...) RADIUS CoA disconnect request, session timeout, idle timeout or client request (PADT). The corresponding RADIUS accounting stop requests will be delayed to wait for the final counter update but uses the timestamp of the terminate request.

Interims Accounting

To receive RADIUS counters in fast intervals the corresponding session interim accounting interval can be set depending on the actual needs to any value between one second and multiple hours or days (recommended is at least 30 seconds). This interval can be also updated via CoA request using the Acct-Interim-Interval attribute which triggers an interim accounting immediately and uses the new interval from now onwards. This can be also used to request interim accounting requests on demand. Sending a CoA request with the applied interval triggers an accounting request but the original interval is not changed.

5.2.5. RADIUS Counters

The packets and byte counters of each session, traffic class (class 0 - 7) as well as policer counters (level 1 to 4) are supported via RADIUS accounting interims and stop messages. Those counters are layer two counters per default which can be adjusted using correction values and factors from the AAA configuration profile.

Subscriber accounting is based on multiple sources like LIF-, class/queue-, policer- and control-traffic statistics which are described below.

- The InLIF (Incoming Logical Interface) stats count all traffic received on the logical interface including control traffic are traffic dropped by ingress policer.
- The policer stats count all traffic accepted by policer (color green) per level (1-4). Ingress control traffic will be hit by a separate control plane policer and therefore not counted in the session policer stats.
- The class/queue stats count all egress traffic except control traffic which is directly sent to the IFP.
- The OutLIF (Outgoing Logical Interface) stats count all traffic sent on the logical interface except control traffic which is directly sent to the IFP.
- The control stats count all traffic received and sent from or to the control plane for a given subscriber (counted in PPPoE daemon for PPPoE sessions).

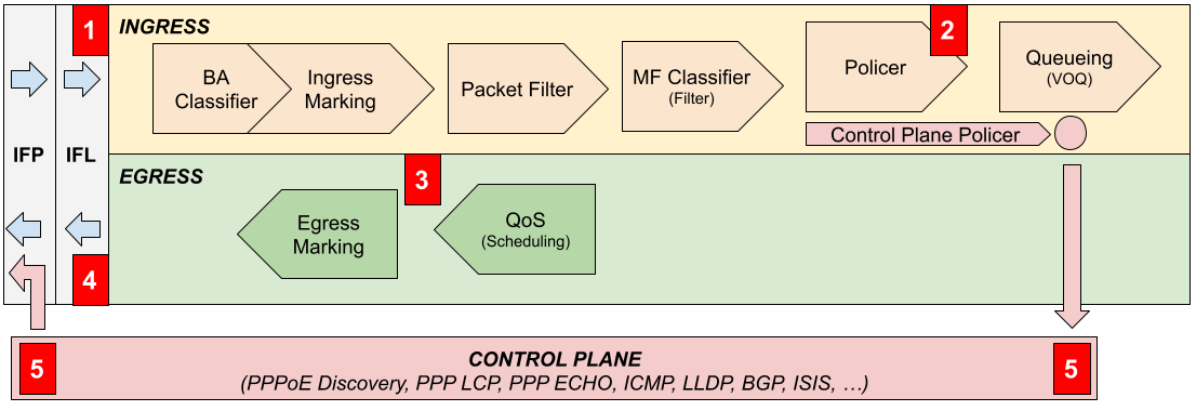


Figure 83. RADIUS Counters



Because counter updates are not atomic operations, the sum of all class counters might be different from the session counters.

The counted bytes per packet can be adjusted as described in chapter Configuring Accounting Adjustments of the Subscriber Management Configuration Guide.

All subscriber accounting attributes and counters are stored without adjustment (L2) in the table **local.access.subscriber.accounting** and remain until the subscriber session is finally removed after response to RADIUS accounting stop.

The command show subscriber <id> accounting displays the adjusted subscriber accounting information. It is also possible to display the values before adjustment using show subscriber <id> accounting origin.

```
supervisor@rtbrick: op> show subscriber 72339069014638637 accounting
Subscriber-Id: 72339069014638637
    IFL: ppp-0/0/1/72339069014638637
    Start Timestamp: Wed Feb 24 09:06:47 GMT +0000 2021
    Idle Timestamp: Wed Feb 24 09:06:47 GMT +0000 2021
    Session-Timeout: 86400 seconds
    Idle-Timeout: 7200 seconds
    Session Statistics:
        Ingress: 0 packets 0 bytes
        Egress: 0 packets 0 bytes
    LIF Statistics:
        Ingress: 14 packets 896 bytes
        Egress: 0 packets 0 bytes
    Egress Class (Queue) Statistics:
        class-0: 0 packets 0 bytes
        class-1: 0 packets 0 bytes
        class-2: 0 packets 0 bytes
        class-3: 0 packets 0 bytes
        class-4: 0 packets 0 bytes
        class-5: 0 packets 0 bytes
        class-6: 0 packets 0 bytes
        class-7: 0 packets 0 bytes
```

```
    Ingress Policer Statistics:
        Level 1: 0 packets 0 bytes
        Level 2: 0 packets 0 bytes
        Level 3: 0 packets 0 bytes
        Level 4: 0 packets 0 bytes
```

Session Counters

Per default, the session counters are calculated using the LIF statistics which include all traffic received on the logical interface (InLIF) and all traffic sent on the logical interface (OutLIF) except control traffic which is directly sent to the IFP. Ingress traffic sent to CPU or transit traffic dropped by policer is still counted whereas egress traffic dropped by QoS is not counted.

Alternatively, it is possible to use the sum of all policer counters for ingress session counters which can be changed in the AAA configuration profile by setting the accounting ingress source to POLICER (default is LIF) to include only accepted transit traffic.

Using LIF in egress and POLICER in ingress results in a symmetric behavior where only accepted transit traffic is counted.

Following the list of the RtBrick class counter attributes.

Attribute	Name	Description
42	Acct-Input-Octets	Incoming session bytes (uint32)
43	Acct-Output-Octets	Outgoing session bytes (uint32)
47	Acct-Input-Packets	Incoming session packets (uint32)
48	Acct-Output-Packets	Outgoing session packets (uint32)
52	Acct-Input-Gigawords	Acct-Input-Octets overflow counter (uint32)
53	Acct-Output-Gigawords	Acct-Output-Octets overflow counter (uint32)

The internal 64 bit counters are split over the standard 32 bit octet and gigaword counters by using the most significant 32 bit as gigawords and the least significant 32 bits as octets.

Internal 64 Bit Counter

32 Bit Acct-Input/Output-Gigawords	32 Bit Acct-Input/Output-Octets

Class Counters

The outgoing class counters are filled by queue counters which ensures that only traffic leaving the device is counted here.

Following the list of the RtBrick class counter attributes.

Attribute	Name	Description
26-50058-81	RtBrick-Class-0-Packets-Out	Outgoing Class-0 packets (uint64)
26-50058-82	RtBrick-Class-0-Bytes-Out	Outgoing Class-0 bytes (uint64)
26-50058-83	RtBrick-Class-1-Packets-Out	Outgoing Class-1 packets (uint64)
26-50058-84	RtBrick-Class-1-Bytes-Out	Outgoing Class-1 bytes (uint64)
26-50058-85	RtBrick-Class-2-Packets-Out	Outgoing Class-2 packets (uint64)
26-50058-86	RtBrick-Class-2-Bytes-Out	Outgoing Class-2 bytes (uint64)
26-50058-87	RtBrick-Class-3-Packets-Out	Outgoing Class-3 packets (uint64)
26-50058-88	RtBrick-Class-3-Bytes-Out	Outgoing Class-3 bytes (uint64)
26-50058-98	RtBrick-Class-4-Packets-Out	Outgoing Class-4 packets (uint64)
26-50058-90	RtBrick-Class-4-Bytes-Out	Outgoing Class-4 bytes (uint64)
26-50058-91	RtBrick-Class-5-Packets-Out	Outgoing Class-5 packets (uint64)
26-50058-92	RtBrick-Class-5-Bytes-Out	Outgoing Class-5 bytes (uint64)

Attribute	Name	Description
26-50058-93	RtBrick-Class-6-Packets-Out	Outgoing Class-6 packets (uint64)
26-50058-94	RtBrick-Class-6-Bytes-Out	Outgoing Class-6 bytes (uint64)
26-50058-95	RtBrick-Class-7-Packets-Out	Outgoing Class-7 packets (uint64)
26-50058-96	RtBrick-Class-7-Bytes-Out	Outgoing Class-7 bytes (uint64)

Those attributes will be encoded as subattributes (RFC2865) similar to broadband forum (BBF) line attributes to reduce the size of the RADIUS message. Counters with a zero value will be also excluded from the packet.

```
▼ AVP: t=Vendor-Specific(26) l=246 vnd=RtBrick Inc.(50058)
    Type: 26
    Length: 246
    Vendor ID: RtBrick Inc. (50058)
  ▶ VSA: t=RtBrick-Class-0-Packets-Out(81) l=10 val=000000000000000a
  ▶ VSA: t=RtBrick-Class-0-Bytes-Out(82) l=10 val=00000000000003e8
  ▶ VSA: t=RtBrick-Class-1-Packets-Out(83) l=10 val=000000000000000b
  ▶ VSA: t=RtBrick-Class-1-Bytes-Out(84) l=10 val=00000000000003e9
  ▶ VSA: t=RtBrick-Class-2-Packets-Out(85) l=10 val=000000000000000c
  ▶ VSA: t=RtBrick-Class-2-Bytes-Out(86) l=10 val=00000000000003ea
  ▶ VSA: t=RtBrick-Class-3-Packets-Out(87) l=10 val=000000000000000d
  ▶ VSA: t=RtBrick-Class-3-Bytes-Out(88) l=10 val=00000000000003eb
  ▶ VSA: t=RtBrick-Class-4-Packets-Out(89) l=10 val=000000000000000e
  ▶ VSA: t=RtBrick-Class-4-Bytes-Out(90) l=10 val=00000000000003ec
  ▶ VSA: t=RtBrick-Class-5-Packets-Out(91) l=10 val=000000000000000f
  ▶ VSA: t=RtBrick-Class-5-Bytes-Out(92) l=10 val=00000000000003ed
  ▶ VSA: t=RtBrick-Class-6-Packets-Out(93) l=10 val=0000000000000010
  ▶ VSA: t=RtBrick-Class-6-Bytes-Out(94) l=10 val=00000000000003ee
  ▶ VSA: t=RtBrick-Class-7-Packets-Out(95) l=10 val=0000000000000011
  ▶ VSA: t=RtBrick-Class-7-Bytes-Out(96) l=10 val=00000000000003ef
  ▶ VSA: t=RtBrick-Policer-L1-Packets-In(97) l=10 val=0000000000000015
  ▶ VSA: t=RtBrick-Policer-L1-Bytes-In(98) l=10 val=00000000000007d1
  ▶ VSA: t=RtBrick-Policer-L2-Packets-In(99) l=10 val=0000000000000016
  ▶ VSA: t=RtBrick-Policer-L2-Bytes-In(100) l=10 val=00000000000007d2
  ▶ VSA: t=RtBrick-Policer-L3-Packets-In(101) l=10 val=0000000000000017
  ▶ VSA: t=RtBrick-Policer-L3-Bytes-In(102) l=10 val=00000000000007d3
  ▶ VSA: t=RtBrick-Policer-L4-Packets-In(103) l=10 val=0000000000000018
  ▶ VSA: t=RtBrick-Policer-L4-Bytes-In(104) l=10 val=00000000000007d4
```

Figure 84. Class Counters

Policer Counters

The incoming policer attributes count all traffic accepted (colored green) by ingress policers with dedicated packet and byte values per level.

Following the list of the RtBrick policer counter attributes.

Attribute	Name	Description
26-50058-97	RtBrick-Policer-L1-Packets-In	Incoming Policer L1 accepted packets (uint64)
26-50058-98	RtBrick-Policer-L1-Bytes-In	Incoming Policer L1 accepted bytes (uint64)
26-50058-99	RtBrick-Policer-L2-Packets-In	Incoming Policer L2 accepted packets (uint64)
26-50058-100	RtBrick-Policer-L2-Bytes-In	Incoming Policer L2 accepted bytes (uint64)
26-50058-101	RtBrick-Policer-L3-Packets-In	Incoming Policer L3 accepted packets (uint64)
26-50058-102	RtBrick-Policer-L3-Bytes-In	Incoming Policer L3 accepted bytes (uint64)
26-50058-103	RtBrick-Policer-L4-Packets-In	Incoming Policer L4 accepted packets (uint64)
26-50058-104	RtBrick-Policer-L4-Bytes-In	Incoming Policer L4 accepted bytes (uint64)

Those attributes will be encoded as subattributes (RFC2865) similar to broadband forum (BBF) line attributes to reduce the size of the RADIUS message. Counters with a zero value will be also excluded from the packet.

Service Classification and Accounting

The underlying virtual output queueing (VOQ) is a common and efficient architecture for high performance switches but brings some major limitations. One obvious limitation is that queues must be allocated in ingress and cannot be changed in egress as shown in the picture below.

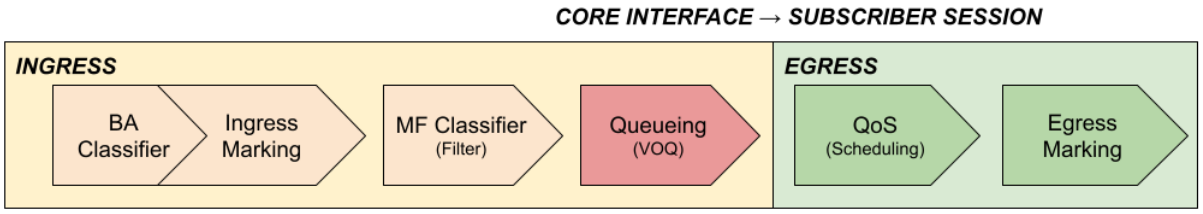


Figure 85. Service Classification and Accounting

Service classification and accounting is based on standard behavior aggregate (BA) and multifield classifier (MF) bound global or to ingress interfaces matching on some protocol fields assigning a traffic class. Downstream traffic (to subscriber) is counted per subscriber and class using queue counters to count only traffic not dropped by QoS. Upstream traffic (from subscribers) is countered per subscriber and policer level.

Some service providers would like to control if premium traffic is handled differently on a per subscriber basis which can be also achieved with VOQ as explained below.

Let us assume a product which handles video streaming services with higher priority or excludes those traffic from actual data volume. With VOQ the classification as Video is done on the ingress core interface equally for all subscribers regardless of the booked product. Now instead of changing the queue per subscriber in egress, the behavior of the queue can be changed to behave equally to BestEffort which is supported in egress per subscriber.

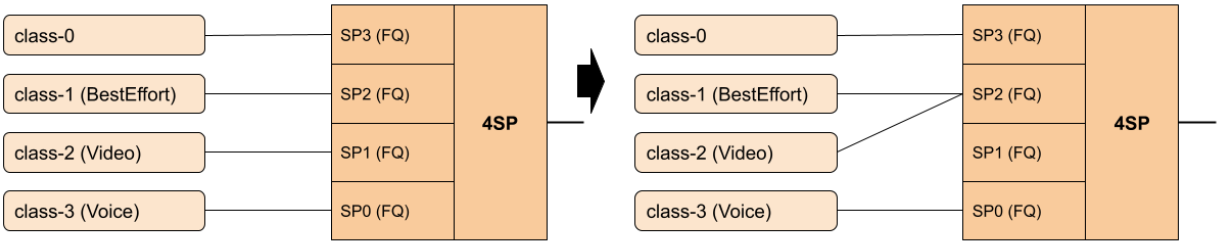


Figure 86. Service Classification

The corresponding Video traffic is now threaded equally to BestEffort but still counted separately. For accounting purposes the traffic of BestEffort and Video can be simply added in the billing infrastructure to get the actual amount of BestEffort traffic.

In upstream, the expected class and policer level can be assigned per subscriber because BA and MF classifiers are bound to the PPPoE session in ingress.

5.2.6. RADIUS Accounting Adjustment Configuration

The accounting adjustment allows to do some basic counter adjustment for RADIUS interims and stop accounting request messages using the following parameters from the AAA configuration profile (**global.access.aaa.profile.config**).

This counter adjustment allows normalizing counters with different encapsulations (double tagged, untagged, ...) to L3 counters for example.

Parameter	Type	Description
accounting_ingress_source	uint8	Source of session ingress counter (1: LIF or 3: POLICER) *Default: LIF*
accounting_egress_source	uint8	Source of session egress counter (1: LIF or 2: CLASS) *Default: LIF*
ingress_byte_adjustment_value	float	Adjust ingress LIF counters by +/-N bytes per packet *Default: 0.00*
ingress_byte_adjustment_factor	float	Adjust ingress LIF counters by factor (executed after adjustment value) *Default: 1.00*
egress_byte_adjustment_value	float	Adjust egress LIF counters by +/-N bytes per packet *Default: 0.00*
egress_byte_adjustment_factor	float	Adjust egress LIF counters by factor (executed after adjustment value) *Default: 1.00*

Parameter	Type	Description
accounting_egress_class_byte_adjustment_value	float	Adjust egress CLASS counters by +/-N bytes per packet *Default: 0.00*
accounting_egress_class_byte_adjustment_factor	float	Adjust egress POLICER counters by factor (executed after adjustment value) *Default: 1.00*
accounting_ingress_policer_byte_adjustment_value	float	Adjust ingress POLICER counters by +/-N bytes per packet *Default: 0.00*
accounting_ingress_policer_byte_adjustment_factor	float	Adjust ingress LIF counters by factor (executed after adjustment value) *Default: 1.00*

The byte adjustment value supports positive and negative values like -20.0 or 20.0. Provided decimal digits in the adjustment values are ignored.

The byte adjustment factors support positive values and only the first two decimal digits are used like 0.98 (-2%) or 1.02 (+2%).

5.2.7. RADIUS Redundancy

It is possible to configure multiple RADIUS authentication and accounting servers for redundancy and or load-balancing.

The following two algorithms are supported:

- **DIRECT (default):** The DIRECT algorithm is designed to primarily focus on **redundancy and fault tolerance**. In this mode, the RBFS subscriber daemon always attempts to send RADIUS requests to a single preferred server. If a response is received, the server continues to be used for subsequent requests. However, if the server becomes unresponsive or times out, the daemon fails over to the next server in the configured list. This process continues

sequentially until a server responds or the list of servers is exhausted.

- **ROUND-ROBIN:** The ROUND-ROBIN algorithm implements **load-sharing** across all configured RADIUS servers. Each outgoing RADIUS request is sent to the next server in the list, circularly rotating through the servers. This allows the authentication and accounting load to be spread evenly across all available servers.

5.2.8. Test AAA

The test AAA subscriber feature allows operators to verify and test authentication and accounting (e.g. local or RADIUS) by emulating a subscriber without the need for external clients to be connected. This is a commonly used feature used during troubleshooting or to validate the RADIUS configuration.

Test subscribers will be created by adding a request object into the test aaa request table (**global.subscriber.1.test.aaa.request**) via API or CLI. This request object includes beside username and password also a spoofed interface, outer-vlan, inner-vlan and MAC address required to build corresponding attributes like NAS port identifiers or the vendor specific RtBrick-Access-Stack. It is also possible to add an Agent-Circuit-Id or Agent-Remote-Id to test line based authentication.

This new object will first trigger a validation plugin to reject invalid requests (e.g. subscriber-id out of range, missing mandatory attributes, ...). The add callback for this object will trigger the creation of the actual subscriber. Deleting the request object will trigger the termination of the subscriber. If this subscriber terminates for other reasons like CoA or CLI, the subscriber remains in a terminated state until the request object is deleted.

Compared to real subscribers, test subscribers will not trigger any forwarding state. Therefore no object will be created in the following tables for those subscribers:

- global.access.1.subscriber.ifl

But the following tables will be populated for operators to check dynamic QoS, filters or IGMP:

- global.access.1.subscriber.qos
- global.access.1.subscriber.qos.shaper

- global.access.1.subscriber.filter
- global.access.1.subscriber.igmp.service

Those entries are ignored internally as there is no matching subscriber interface (IFL) (global.access.1.subscriber.ifl). The only exception here is the filter table meaning that received filters (ADF) learned from RADIUS are installed in the ACL table and applied with the IP addresses of the test subscribers.

Test AAA Subscriber-Id:

In RBFS each subscriber is uniquely identified by subscriber-id which is a 64 bit number allocated in a distributed fashion by the application creating the subscriber (for example, pppoed for pppoe sessions). This uniqueness is achieved with the following format.

The first 8 bits are used to identify the application:

- 0x00 subscriberd
- 0x01 pppoed
- 0x02 l2tpd

The next 8 bits are used to identify the application sharding instance allocated (for example, pppoed.1, pppoed.2, and so on).

The remaining 48 bits are used to uniquely identify the subscriber, which theoretically allows up to 281474976710656 subscribers per application instance.

An emulated test subscriber needs also a subscriber-id.

```
-----
* 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1

* +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+

* | app-id (0) | app-instance | reserved |

* +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+

* | subscriber

* +-+-+-+-+

-----
```

Assuming subscriber daemon instance 1 (subscriberd.1), the valid range for test subscriber identifiers is between 281474976710656 and 281479271677951.

```
Min Subscriber-Id: 281474976710656
0000 0000 0000 0001 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000

Max Subscriber-Id: 281479271677951
0000 0000 0000 0001 0000 0000 0000 0000 1111 1111 1111 1111 1111 1111 1111 1111
```

The subscriber identifier will be allocated manually by operators from this range which has the advantage to easier identify the subscriber created by request.

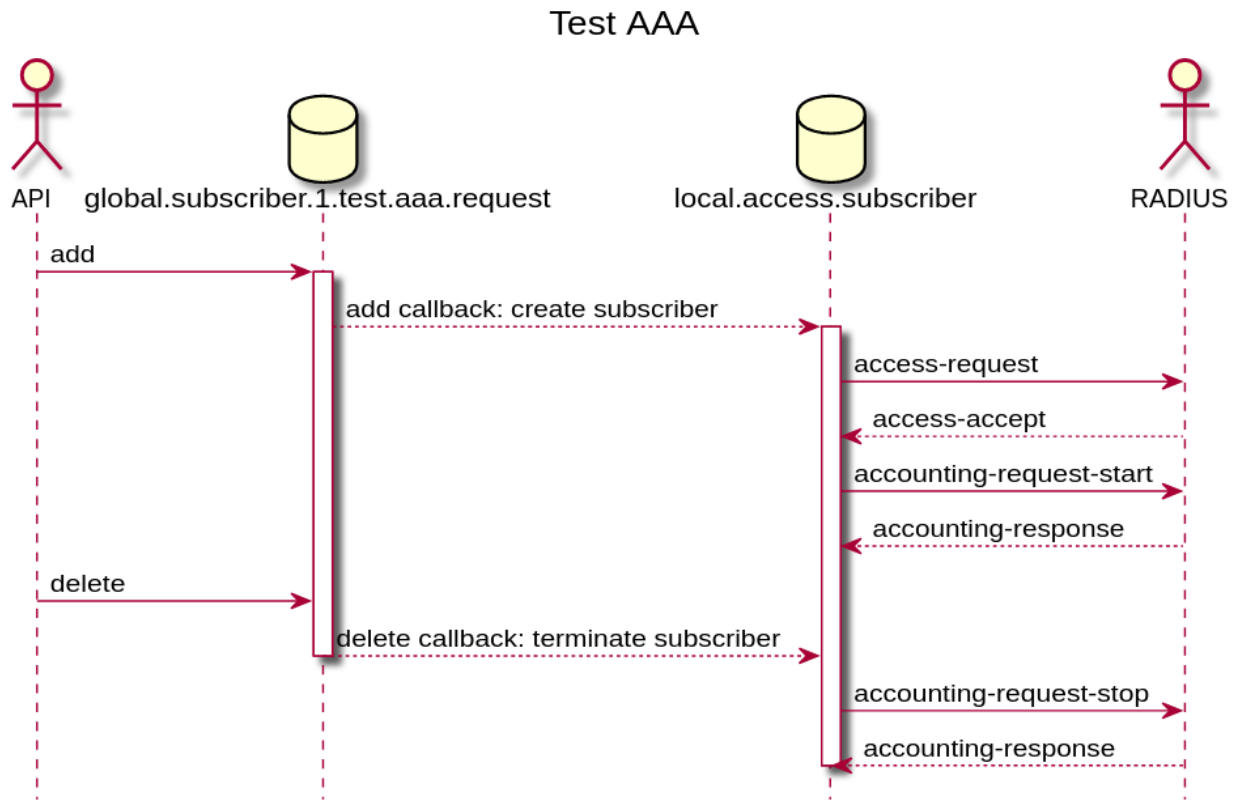


Figure 87. Test AAA RADIUS Flow

Test AAA Attributes

Attribute	Mandatory	API	CLI	Default
Subscriber-Id	Yes	subscriber_id	subscriber-id	
Access Profile	Yes	access_profile_name	access-profile	
AAA Profile	Yes	aaa_profile_name	aaa-profile	

Attribute	Mandatory	API	CLI	Default
Username	No	user_name	username	test
Password	No	password	password	test
Agent-Circuit-id	No	aci	aci	
Agent-Remote-id	No	ari	ari	
Interface (IFP)	*	interface_name	interface	ifp-0/0/0
Outer VLAN	No	outer_vlan	outer-vlan	0
Inner VLAN	No	inner_vlan	inner-vlan	0
MAC Address	No	client_mac	**	00:00:00:00:00:00

** The interface is mandatory via CLI but optional via API.*

*** The client MAC address is currently supported via API only.*

Test AAA via CLI



In CLI, strings must not contain the “” character and therefore this is not permitted for username, aci or ari set via CLI. This limitation is valid for CLI only as subscribers created via API are allowed to use the “” character in the mentioned strings.

Add Test Subscriber:

```
supervisor@leaf1: op> test subscriber aaa request 281474976710656 pppoe-dual aaa-
default ifl-0/0/1 username user1@rtbrick.com aci "0.0.0.0/0.0.0.0 eth 0/0" ari
DEU.RTBRICK.01
```

List All Test Subscribers:

```
supervisor@leaf1: op> show subscriber filter type Test
Subscriber-Id          Interface        VLAN      State              Username
281474976710656        ifp-0/1/23       0:0       ESTABLISHED
user1@rtbrick.com
```

Delete Test Subscriber:

```
supervisor@leaf1: op> test subscriber aaa delete 281474976710656
```

Test AAA via API

Add Test Subscriber:

```
{{rbfs_url}}/api/v1/rbfs/elements/{\{element}}/services/subscriberd.1/proxy/bds/ob
ject/add
```

```
{
   "table": {
       "table_name": "global.access.1.test.aaa.request"
   },
   "objects": [
       {
           "attribute": {
               "subscriber_id": 281474976710658,
               "aaa_profile_name": "aaa-default",
               "access_profile_name": "pppoe-dual",
               "user_name": "user@rtbrick.com",
               "ari": "DEU.RTBRICK.01",
               "aci": "0.0.0.0/0.0.0.0 eth 0/0"
           }
       }
   ]
}
```

Delete Test Subscriber:

```
{{rbfs_url}}/api/v1/rbfs/elements/{\{element}}/services/subscriberd.1/proxy/bds/ob
ject/delete
```

```
{
   "table": {
       "table_name": "global.access.1.test.aaa.request"
   },
   "objects": [
       {
           "attribute": {
               "subscriber_id": 281474976710658
           }
       }
   ]
}
```

List All Test Subscribers:

```
{{rbfs_url}}/api/v1/rbfs/elements/{\{element}}/services/subscriberd.1/proxy/bds/ta
```

```
ble/walk
```

```
{
   "table": {
       "table_name": "global.access.1.test.aaa.request"
   }
}
```

5.2.9. Appendix A - RADIUS Dictionary

Following the RtBrick RADIUS dictionary in the well known FreeRADIUS format.

```
# This dictionary applies to RtBrick Full Stack (RBFS)
# https://www.rtbrick.com/
#
VENDOR          RtBrick 50058

BEGIN-VENDOR    RtBrick

ATTRIBUTE       RtBrick-Access-Hostname             21  string
ATTRIBUTE       RtBrick-Access-Port                 22  string
ATTRIBUTE       RtBrick-Access-Stack                23  string
ATTRIBUTE       RtBrick-Access-MAC-Address          24  string

ATTRIBUTE       RtBrick-Subscriber-Id               25  integer64
ATTRIBUTE       RtBrick-Subscriber-Ifl              26  string

ATTRIBUTE       RtBrick-Terminate-Code              27  integer

ATTRIBUTE       RtBrick-DHCPv4-Client-Options       30  octets
ATTRIBUTE       RtBrick-DHCPv4-Server-Options       31  octets
ATTRIBUTE       RtBrick-DHCPv6-Client-Options       32  octets
ATTRIBUTE       RtBrick-DHCPv6-Server-Options       33  octets

ATTRIBUTE       RtBrick-L2TP-Pool                   40  string
ATTRIBUTE       RtBrick-L2TP-Profile                41  string
ATTRIBUTE       RtBrick-L2TP-Tx-Connect-Speed       42  integer
ATTRIBUTE       RtBrick-L2TP-Rx-Connect-Speed       43  integer

ATTRIBUTE       RtBrick-QoS-Profile                 62  string
ATTRIBUTE       RtBrick-QoS-Shaper                  63  string
ATTRIBUTE       RtBrick-QoS-Parent-Scheduler        64  string
ATTRIBUTE       RtBrick-QoS-Policer                 65  string
ATTRIBUTE       RtBrick-QoS-MFC                     66  string
ATTRIBUTE       RtBrick-QoS-Queues                  67  string

ATTRIBUTE       RtBrick-AAA-Profile                 69  string
ATTRIBUTE       RtBrick-Service-Profile             70  string

ATTRIBUTE       RtBrick-IGMP-Status                 71  integer
ATTRIBUTE       RtBrick-IGMP-Profile                72  string
ATTRIBUTE       RtBrick-IGMP-Version                73  integer
ATTRIBUTE       RtBrick-IGMP-Max-Members            74  integer

ATTRIBUTE       RtBrick-HTTP-Redirect-URL           75  string
```

```
ATTRIBUTE       RtBrick-IPv4-ACL-In                 76  string
ATTRIBUTE       RtBrick-IPv4-ACL-Out                77  string
ATTRIBUTE       RtBrick-IPv6-ACL-In                 78  string
ATTRIBUTE       RtBrick-IPv6-ACL-Out                79  string

ATTRIBUTE       RtBrick-Class-0-Packets-Out         81  integer64
ATTRIBUTE       RtBrick-Class-0-Bytes-Out           82  integer64
ATTRIBUTE       RtBrick-Class-1-Packets-Out         83  integer64
ATTRIBUTE       RtBrick-Class-1-Bytes-Out           84  integer64
ATTRIBUTE       RtBrick-Class-2-Packets-Out         85  integer64
ATTRIBUTE       RtBrick-Class-2-Bytes-Out           86  integer64
ATTRIBUTE       RtBrick-Class-3-Packets-Out         87  integer64
ATTRIBUTE       RtBrick-Class-3-Bytes-Out           88  integer64
ATTRIBUTE       RtBrick-Class-4-Packets-Out         89  integer64
ATTRIBUTE       RtBrick-Class-4-Bytes-Out           90  integer64
ATTRIBUTE       RtBrick-Class-5-Packets-Out         91  integer64
ATTRIBUTE       RtBrick-Class-5-Bytes-Out           92  integer64
ATTRIBUTE       RtBrick-Class-6-Packets-Out         93  integer64
ATTRIBUTE       RtBrick-Class-6-Bytes-Out           94  integer64
ATTRIBUTE       RtBrick-Class-7-Packets-Out         95  integer64
ATTRIBUTE       RtBrick-Class-7-Bytes-Out           96  integer64

ATTRIBUTE       RtBrick-Policer-L1-Packets-In       97  integer64
ATTRIBUTE       RtBrick-Policer-L1-Bytes-In         98  integer64
ATTRIBUTE       RtBrick-Policer-L2-Packets-In       99  integer64
ATTRIBUTE       RtBrick-Policer-L2-Bytes-In        100  integer64
ATTRIBUTE       RtBrick-Policer-L3-Packets-In      101  integer64
ATTRIBUTE       RtBrick-Policer-L3-Bytes-In        102  integer64
ATTRIBUTE       RtBrick-Policer-L4-Packets-In      103  integer64
ATTRIBUTE       RtBrick-Policer-L4-Bytes-In        104  integer64

ATTRIBUTE       RtBrick-DNS-Primary                131  ipaddr
ATTRIBUTE       RtBrick-DNS-Secondary              132  ipaddr
ATTRIBUTE       RtBrick-DNS-Primary-IPv6           134  ipv6addr
ATTRIBUTE       RtBrick-DNS-Secondary-IPv6         135  ipv6addr

ATTRIBUTE       RtBrick-Instance                   137  string
ATTRIBUTE       RtBrick-Gateway-Ifl                138  string

ATTRIBUTE       RtBrick-Connection-Status-Message  139  string

ATTRIBUTE       RtBrick-LI-Action                  140  integer encrypt=2
ATTRIBUTE       RtBrick-LI-Identifier              141  integer encrypt=2
ATTRIBUTE       RtBrick-LI-Direction               142  integer encrypt=2
ATTRIBUTE       RtBrick-LI-MED-Instance            143  string  encrypt=2
ATTRIBUTE       RtBrick-LI-MED-IP                  144  ipaddr  encrypt=2
ATTRIBUTE       RtBrick-LI-MED-Port                145  integer encrypt=2

#         VALUE MAPS
#
#       Attribute               Name        Number
VALUE   RtBrick-LI-Action       NOOP        0
VALUE   RtBrick-LI-Action       ON          1
VALUE   RtBrick-LI-Action       OFF         2

VALUE   RtBrick-LI-Direction    INGRESS     1
VALUE   RtBrick-LI-Direction    EGRESS      2
VALUE   RtBrick-LI-Direction    BOTH        3

VALUE   RtBrick-IGMP-Status     DISABLED    0
VALUE   RtBrick-IGMP-Status     ENABLED     1
```

```
VALUE   RtBrick-IGMP-Version    V1          1
VALUE   RtBrick-IGMP-Version    V2          2
VALUE   RtBrick-IGMP-Version    V3          3

END-VENDOR RtBrick
```



- The **RtBrick-DHCP-Client-Options** and **RtBrick-DHCPv6-Client-Options** attributes enable the transmission of DHCPv4/DHCPv6 options in the Access-Accept message as payload. These options are added to packets sent to the client, operating in relay/proxy mode or server mode.
- The **RtBrick-DHCP-Server-Options** and **RtBrick-DHCPv6-Server-Options** attributes are only supported in relay/proxy mode and are used to add options in packets sent toward the DHCP server.

5.2.10. Appendix B - RADIUS Standard Attributes Supported

Disclaimer Note: The following table presents the current development state of the RADIUS attributes supported in RBFS. Some of these may be incomplete and are subjected to change at any time without any notice.

RFC	Attribute		Access		Accounting				CoA	
	#	Name	Request	Response	Acct-Start	Acct-Interim	Acct-Stop	Acct-On	Request	Response

2865

	Messa ge								
25	Class		X	X	X	X			
32	NAS-Identifier	X		X	X	X	X		
61	NAS-Port-Type	X		X	X	X			

2688	40	Acct-Status-Type			X	X	X	X		
	41	Acct-Delay-Time								
	42	Acct-Input-Octets				X	X			
	43	Acct-Output-Octets				X	X			
	44	Acct-Session-ID	X		X	X	X			
	45	Acct-Authentic								
	46	Acct-Session-Time					X			
	47	Acct-Input-Packets				X	X			
	48	Acct-Output-Packets				X	X			
	49	Acct-Terminate-Cause					X			

2869	52	Acct-Input-Gigawords				X	X			
	53	Acct-Output-Gigawords				X	X			
	55	Event-Timestamp			X	X	X			
2865	60	CHAP-Challenge	X							

2868	64	Tunnel-Type		X	X	X	X			
	65	Tunnel-Medium-Type		X						
	66	Tunnel-Client-Endpoint		X	X	X	X			
	67	Tunnel-Server-Endpoint		X	X	X	X			
	69	Tunnel-Password		X						
	81	Tunnel-Private-Group-ID		X	X	X	X			
	82	Tunnel-Assignment-ID		X	X	X	X			
	83	Tunnel-Preference		X					X	

2869	85	Acct-Interim-Interval	X						X	
	87	NAS-Port-Id	X		X	X	X			
	88	Framed-Pool		X						
2868	90	Tunnel-Client-Auth-ID		X	X	X	X			
	91	Tunnel-Server-Auth-ID		X	X	X	X			
3162	97	Framed-IPv6-Prefix		X	X	X	X			
	100	Framed-IPv6-Pool		X						
3576	101	Error-Cause								X
4818	123	Delegated-IPv6-Prefix		X	X	X	X			

6911	171	Delegated-IPv6-Prefix-Pool		X						

4679

	m-Low-Power								
26-3561-139	Maximum-Interleaving-Delay-Upstream	X	X	X	X	X			
26-3561-140	Actual-Interleaving-Delay-Upstream	X	X	X	X	X			
26-3561-141	Maximum-Interleaving-Delay-Downstream	X	X	X	X	X			
26-3561-142	Actual-Interleaving-Delay-Downstream	X	X	X	X	X			
26-3561-144	Access-Loop-Encapsulation	X	X	X	X	X			

RtBrick

26-50058-140	RtBrick-LI-Action		X					X	
26-50058-141	RtBrick-LI-Identifier		X					X	
26-50058-142	RtBrick-LI-Direction		X					X	
26-50058-143	RtBrick-LI-MED-Instance		X					X	
26-50058-144	RtBrick-LI-MED-IP		X					X	
26-50058-145	RtBrick-LI-MED-Port		X					X	

5.2.11. Appendix C - Access Deployments

The following picture shows different deployments typically used in access networks.

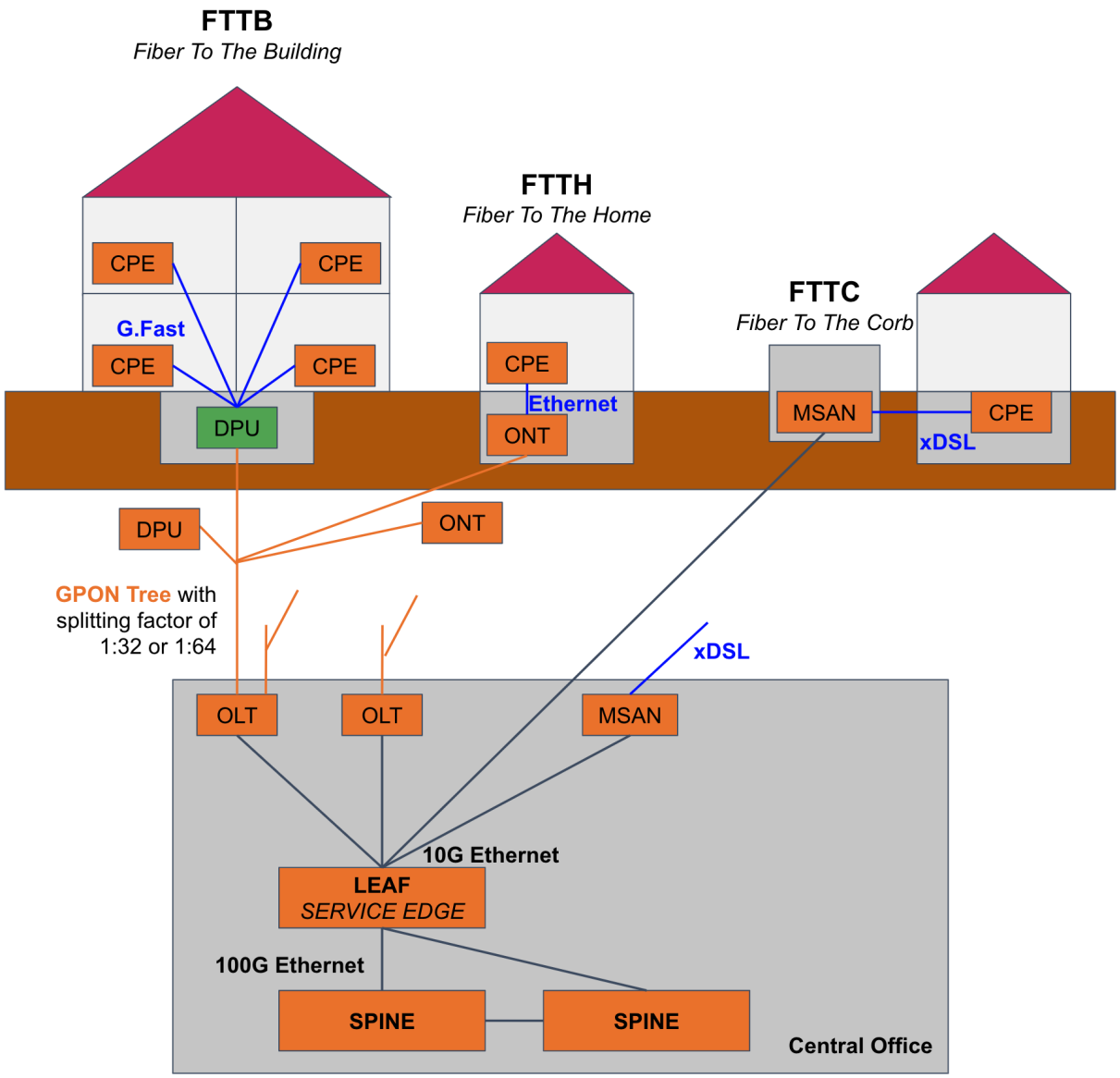


Figure 88. Access Deployments

The LEAF and SPINE are bare metal switches running RBFS where the LEAF is responsible for service edge functionalities like PPPoE subscriber termination and the SPINE builds the actual fabric core. Multiple LEAF switches will be connected to a pair of spine switches.

5.3. RBFS Carrier-Grade Network Address Translation

5.3.1. Carrier-Grade Network Address Translation Overview

Carrier-Grade NAT

The rise of technologies and the rapid growth of mobile devices and cloud services worldwide resulted in the exhaustion of IPv4 addresses. Broadband service providers face a growing challenge as this 32-bit address is insufficient to meet the ever-growing demand and the cost of obtaining public IP addresses for every individual subscriber. Though the launch of IPv6 can address the IPv4 depletion problem, migrating to an IPv6 network becomes vastly complex and costly. IPv6 also does not provide backward compatibility with IPv4. Consequently, migrating to IPv6 is not an ideal solution for many broadband service providers.

Carrier-Grade Network Address Translation (CGNAT) is a prominent technology solution that addresses the IPv4 exhaustion challenge of service providers. The solution helps to use private network addresses and to limit the use of publicly routable IPv4 addresses significantly.

CGNAT allows service providers to serve a large number of their subscribers using a limited number of public IPv4 addresses. It saves costs on public IPv4 addresses and conserves their IPv4 address pools.

Static NAT

Static NAT associates one private IP address with one public IP address. This is a one-to-one mapping and you must manually define the mapping between a private and public address.

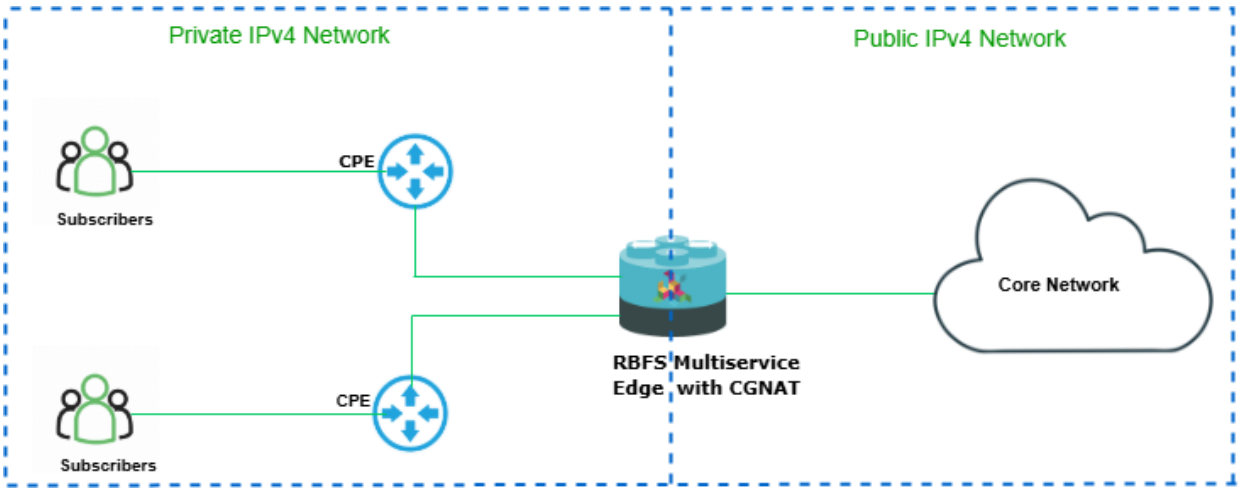
Dynamic NAT

In Dynamic NAT, internal private IPv4 addresses are mapped with a public IPv4 address and this mapping of a private IPv4 address to a public IPv4 address happens dynamically. The router dynamically picks an address from the address pool that is not currently assigned.

NAT444

CGNAT supports NAT444. NAT 444 refers to three sets of IPv4 addresses: Customer private, ISP private, and public Internet. Network address translation occurs from customer private to ISP private, and then ISP private to public. The NAT444, also known as CGNAT, functionality maps IPv4 subscriber private addresses to IPv4 public addresses.

The following diagram illustrates a high-level view of CGNAT.



CGNAT Benefits

CGNAT allows service providers to provide services to a large number of their subscribers using a limited number of public IPv4 addresses. The benefits include:

Conserve Public IPv4 Addresses

The solution helps service providers conserve expensive public IPv4 addresses by enabling multiple subscribers to share a single public IPv4 address. With CGNAT, one public IPv4 address can manage hundreds of devices within the private network. It reduces the requirement of continually buying additional public IP addresses.

Enhance Security

In addition to stretching the limited pool of public IPv4 addresses even further, CGNAT also provides significant security benefits. It helps to enhance network security by keeping the internal addressing private from the external network. It makes it difficult for attackers to target specific devices on the network by preventing attacks that target specific IP addresses.

Performance at Carrier-Grade

The CGNAT solution implements the functions of IPv4 address translation in the network of service providers. Service providers can deploy NAT in a way that allows multiple subscribers to share a single global IPv4 address and scale to several thousands of address translations. CGNAT operations are implemented at the forwarding plane (hardware level) to ensure optimal performance. This hardware-

level implementation achieves high throughput with no performance impact and packet processing occurs without overburdening the CPU. The solution offers carrier-grade scalability with fast translation rates and a large number of IPv4 address and port number translations.

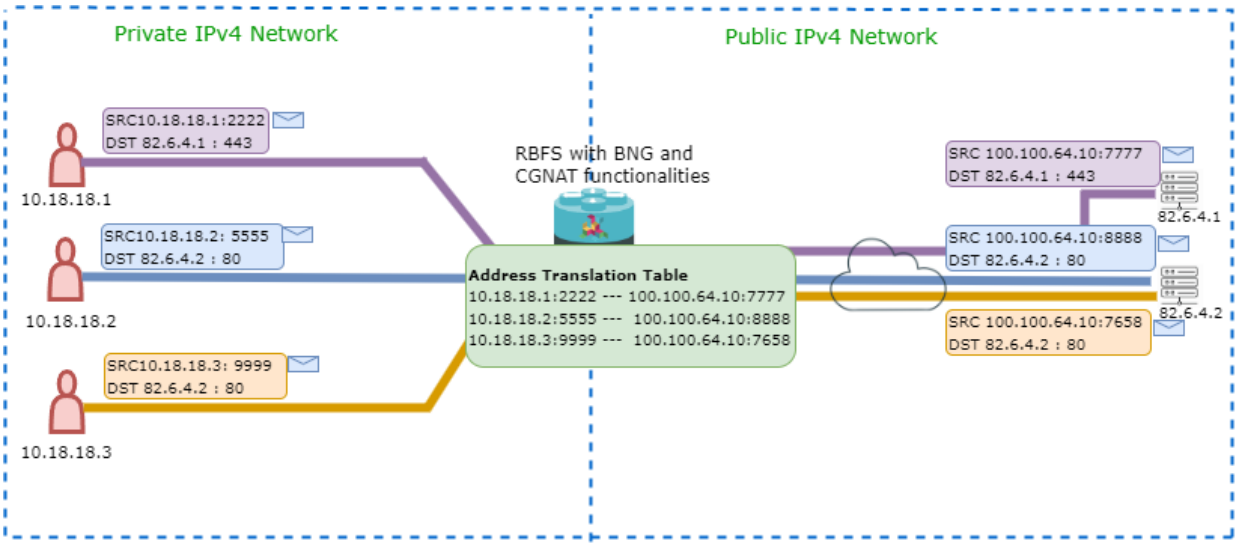
Understanding CGNAT Implementation

CGNAT solution has been designed to support Port Address Translation, also known as Network Address Port Translation (NAPT), which has the greatest potential to conserve IPv4 addresses for service providers. NAPT is known as an effective method to allow multiple devices to connect to the Internet using a single public IPv4 address.

Network Address Port Translation

Network Address Port Translation is a dynamic NAT in which port numbers along with IP address are used to identify which traffic belongs to which private IP address. CGNAT translates the source private IPv4 address and port number to a public source IPv4 address and unique port number. This allows multiple devices with different private IP addresses to use a single public IPv4 address. The unique port number ensures that the traffic is delivered to the correct device.

The following diagrams illustrate how CGNAT works at a high level.



The diagram shows three subscribers using private IPv4 addresses (10.18.18.1, 10.18.18.2, and 10.18.18.3 send traffic to two different servers (82.6.4.1 and 82.6.4.2) on the public network.

BNG with CGNAT performs the address translation by replacing the source private IPv4 address with the public IPv4 address from the address pool and the source port number with a unique port number. After the address translation, the device forwards the traffic to the destination servers. After the translation, packets have a new source IPv4 address which is the public IPv4 and a unique port number as per the mapping in the address translation table.

CGNAT maintains a translation table with the entries. Entries are records of mapped private IPv4 addresses and port numbers with the public IPv4 addresses and port numbers.

The downstream traffic from the servers traverses to the CGNAT device. The packets coming from external hosts include the destination address as the (translated) public IPv4 address. CGNAT device performs reversal address translation for these packets as per the translation table mapping for the downstream traffic.

NAPT helps to significantly reduce the number of logs generated as it generates logs only during the allocation and release of each block of ports.

Deterministic NAT

CGNAT offers support for deterministic NAT mode, which provides a consistent mapping of private IPv4 addresses with public IPv4 addresses and port ranges. This mode ensures a one-to-one mapping of private IPv4 addresses with public IPv4 addresses, allowing you to specify the private address and its matching public address and port range. The given private IPv4 address is always translated to the same public address.

In addition, deterministic NAT guarantees a predetermined and fixed translation for a given internal address with a public IPv4 and port combination, ensuring consistency and stability in the mapping. This feature is particularly useful for applications that involve security protocols, as well as for service providers who need to track subscriber sessions.

Furthermore, deterministic NAT significantly reduces address translation logs, as private IPv4 addresses are always mapped to public IPv4 addresses and port ranges.

Address Translation Table

Port mapping is a feature that allows multiple devices to share the same public IPv4 address with different port numbers. CGNAT generates a unique port number for each subscriber session. Port mapping helps to determine the correct host among the many devices in the private network that use the same public IPv4 address.

CGNAT maintains an address translation table that maps private IPv4 addresses and port numbers to their corresponding public IPv4 addresses and ports. Whenever an incoming packet arrives, CGNAT checks the translation table to see if a translation entry exists for that packet. If there’s an entry, the CGNAT replaces the source IPv4 address and port number in the packet header with the mapped public IPv4 address and port number.

When a device on the Internet sends packets downstream, the CGNAT software uses the translation table for address translation reversal. It replaces the destination public IPv4 address and port number in the packet header with the corresponding private IPv4 address and port number.

NAT IP Pools and Chaining

A NAT pool contains a range of multiple public IP addresses. You can create multiple pools and associate them with a NAT service. Pool chaining is a method in which you can associate one pool with another. For a pool, you can define 'next pool name'; so that when the pool gets exhausted with the IPv4 addresses, the next pool that is defined will take over.

Ageing

Ageing refers to the time that a translation entry exists or remains in the address translation table after it was last used.

The entries in the translation table have a finite lifespan as the software implements mechanisms to handle session timeouts.

When a host sends a packet to a destination, CGNAT translates the private IPv4 address and port to a public IPv4 address and port. This mapping is recorded as an entry in the address translation table. The software always looks up the translation table whenever it receives a packet to verify that any entry exists for the packet in the translation table. The software performs the address translation based on the

recorded entries and its associated mappings for both inbound and outbound packets.

If there is no activity related to a specific mapping (for example, when there are no incoming or outgoing packets), the mapping will eventually be removed from the address translation table, once idle or unused entries are detected, entries removed from the address translation table to free up resources for the new upcoming traffic flows.

For TCP, idle or unused flows are typically detected by the receipt of TCP FIN-ACK packets, which indicate that both sides of the connection have finished sending data. Once detected, these flows are removed after a configurable aging timer expires.

For UDP, as it is a connectionless protocol, idle or unused flows are detected by periodically polling the flow traffic. As the number of UDP traffic flows increases, the idle flow detection mechanism also increases, ensuring that idle flows are removed in a timely manner. The aging of UDP flows is proportional to the number of traffic flows.

Ageing Timeout for UDP-based DNS Traffic

You can define an ageing timeout that controls how long the system maintains state information for UDP-based DNS traffic before considering the flow inactive and clearing it from the NAT table.

UDP traffic has a default ageing timeout of 30 seconds in NAT implementation.



The NAT ageing timeout is 300 seconds for TCP and UDP traffic. The actual time taken to flush aged-out NAT rules depends on the number of NAT rules and the number of counters.

Support for IPoE N:1 Shared VLAN in Single VRF

CGNAT is supported for the IPoE N:1 shared VLAN model within the same VRF instance.

Logging

RBFS provides traffic monitoring capabilities to track and log network activities. You can enable logging for CGNAT operations.

Logging is not completely supported on CGNAT.

NAT for ICMP Messages

The NAT-enabled RBFS devices can perform network address translation for ICMP echo request and reply messages. Subscribers can use ping command (ICMP Echo Request, Echo Reply) to check internet connectivity to external internet addresses when NAT is enabled. This feature is enabled by default.

NAT for TCP Control Messages

RBFS with NAT supports address translation for TCP control messages using ACLs. It includes the TCP control messages such as FIN, FIN-ACK, RST, RST-ACK, SYN, and SYN-ACK. This feature is enabled by default.

CGNAT Support for Traceroute

The RBFS CGNAT provides support for Traceroute and critical ICMP error handling on certain platforms. This feature ensures that diagnostic tools can function correctly across NAT boundaries by accurately translating and forwarding "TTL Exceeded" and "Fragmentation Needed" messages.

NAT-miss Traffic Handling in Control Plane on Q2C Platforms

RBFS supports a mechanism to handle NAT-miss packets at control plane. A NAT-miss occurs when a downstream packet arrives at a device configured for address translation, but no matching NAT rule exists for that flow. A new ACL rule issued to detect such packets based on NAT-miss status and destination prefix match. These packets are redirected to the control plane, which performs network address translation in software and forwards them.

CGNAT N:1 with ACL-Based NAT Control

In a BNG N:1 deployment, CGNAT by default is enabled or disabled for all subscribers in the same VLAN as configured in the NAT profile. If, however, it is required to have a mix of NAT and non-NAT subscriber in a VLAN, then NAT needs to be enabled for all subscribers in the VLAN and an ACL needs to be configured using the IPv4 prefix of each subscriber or set of subscribers for whom the NAT needs to be disabled, to override the NAT profile configuration from getting applied.

NAT Enabled Subscribers:

By default, all subscribers undergo address translation via CGNAT. However, specific subscribers can be configured to bypass NAT using ACL rules. This allows selected subscribers to be forwarded without translation.

Non-NATed Subscribers:

All subscribers are, by default, forwarded without NAT when the service profile is configured as non-NATed. In this mode, selective NAT enablement for some specific subscribers through ACLs is not supported. Subscribers designated as non-NATed remain excluded from NAT processing.



You can configure ACLs to exclude specific subscribers from NAT in a NAT-enabled environment. You cannot include specific subscribers for NAT in a non-NATed environment.

Example: NAT Bypass for Specific Subscribers

In a CGNAT N:1 deployment, subscribers within the same VLAN (for example, VLAN 100) and in the 198.51.100.0/24 range are configured with NAT enabled by default. Under normal operation, all subscriber traffic in this VLAN is translated using CGNAT.

In this scenario, specific subscribers (198.51.100.10 and 198.51.100.20) in the same VLAN require direct internet access without NAT. To meet this requirement, an ACL is configured to match these subscriber IP addresses. The ACL overrides the default NAT behavior for the matched subscribers within the VLAN and bypasses translation. As a result, traffic from 198.51.100.10 and 198.51.100.20 is forwarded without NAT, while all other subscribers in the VLAN continue to be NATed. This approach enables selective NAT bypass within a shared VLAN without modifying the overall service profile.

For configuration information, see the Selective NAT Bypass for Subscribers Using ACLs section.

Guidelines and Limitations

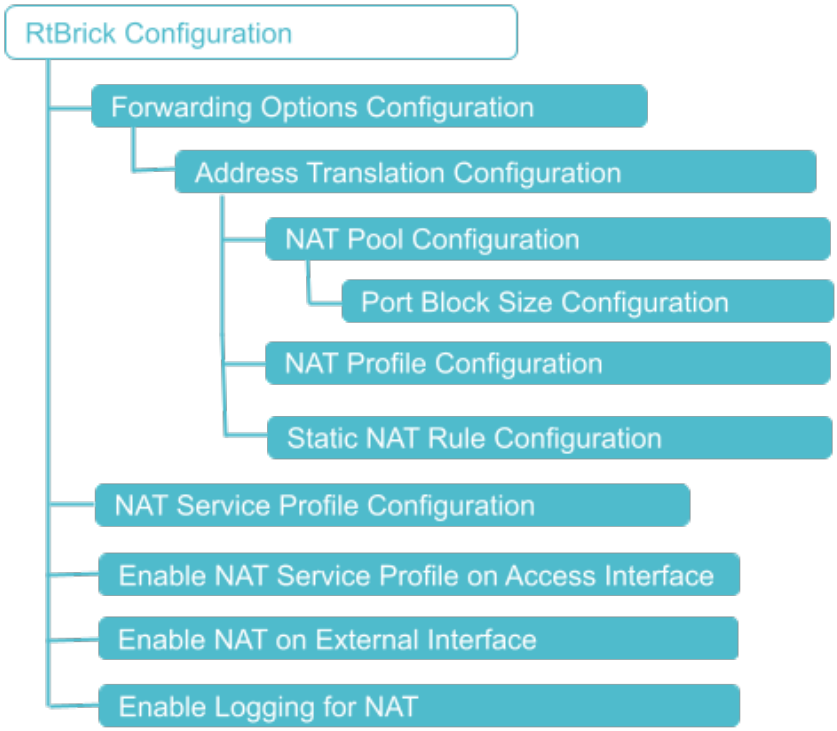
- On Q2A platforms, avoid installing IP forwarding routes that overlap with the public IP address range used for CGNAT.

Supported Platforms

Not all features are necessarily supported on each hardware platform. Refer to the *Platform Guide* for the features and the sub-features that are or are not supported by each platform.

5.3.2. Carrier-Grade NAT Configuration

Configuration Hierarchy



Prerequisites

Before configuring CGNAT, ensure that the appropriate platform profile is configured on the device. The platform profile determines the operating mode of the system and enables the required hardware resources for NAT functionality.

Configure one of the following platform profiles based on the deployment type:

- Use nat_1q or nat_4q profile when the system operates as a RBFS CGNAT, where NAT is integrated with subscriber management.
- Use this nat_standalone profile when the system operates as a dedicated CGNAT appliance without BNG subscriber functionality.

The platform profile must be configured and the system must be rebooted before proceeding with the CGNAT configuration.

Reboot the system for the changes to take effect, after setting the platform profile. For information about Platform Profile configuration, see Platform Profile.

CGNAT Configuration

You must perform the following tasks to configure CGNAT.

1. Configure NAT Pool
2. Configure NAT Profile
3. Configure NAT Rule
4. NAT Service Profile Configuration
5. Enable NAT on an Instance
6. Enable NAT Service Profile on Access Interface
7. Enable NAT on External Interface
8. Enable Logging for NAT
9. Enabling NAT ACL Support for ICMP and TCP Control Messages

Configuration Syntax and Commands

The following sections describe the CGNAT configuration syntax and commands.

Configuring NAT Profile

A NAT profile defines how the NAT device has to perform the IPv4 address translation. NAT profile allows you to define an instance, IPv4 address pools, maximum number of translations, and mapping a particular internal IPv4 address with a particular external IPv4 address for a deterministic address translation.

A single NAT profile can be attached to subscribers across different instances. This means that regardless of which instance a subscriber belongs to, they can share the same NAT profile. For example, subscribers in different routing instances can be managed using the same NAT settings.

Subscribers within the same instance can be assigned different NAT profiles. Different groups of subscribers or services within the same instance can have

tailored NAT configurations.



The configuration limit of NAT rules per subscriber in NAT profile is 16,384.

Syntax:

set forwarding-options address-translation profile <profile-name> <attribute> <value>

Attribute	Description
<profile-name>	Specify the NAT profile name.
deterministic [true]	Specify deterministic as true to enable deterministic NAT for the profile. Deterministic NAT allows subscribers always to connect with a single public IP.
ip-protocol	Specify the protocol: tcp, udp, or other.
ip-protocol ageing-timeout <ageing-timeout>	Specify the ageing time value for the protocol. Default, 300 seconds for TCP and UDP. The allowed Ageing Time Out range values are as follows: TCP: 60 - 86400 seconds UDP: 120 - 86400 seconds
ip-protocol control-plane-ageing-timeout <ageing-timeout>	Specify the TCP/UDP control plane ageing timeout value. The default values are as follows: TCP-control-plane: 10 seconds UDP-control-plane: 30 seconds The allowed Ageing Time Out range values are as follows: TCP Control-plane: 5 - 120 UDP Control-plane: 5 - 120 Other: 120 - 86400
max-rules	Specify the maximum number of rules per subscriber or an interface. The supported values for maximum address translation per subscriber or an interface are 64, 128, 256, 512, 1024, 2048, 4096, 8192, and 16384.

Attribute	Description
pool	Specify the name of the public IP address pool.

The following commands configure the NAT profile named nat_profile1. The nat profile nat_profile1 is configured on the instanced vrf1 with a pool attached nataddr_pool1. Maximum rules are configured as 128 rules and the aging period is configured as 600 seconds for TCP traffic, 300 seconds for UDP traffic, and 300 for 'other' traffic.

```
set forwarding-options address-translation profile nat_profile1
set forwarding-options address-translation profile nat_profile1 pool nataddr_pool1
set forwarding-options address-translation profile nat_profile1 max-rules 128
set forwarding-options address-translation profile nat_profile1 ip-protocol tcp
ageing-timeout 600
set forwarding-options address-translation profile nat_profile1 ip-protocol udp
ageing-timeout 300
set forwarding-options address-translation profile nat_profile1 ip-protocol other
ageing-timeout 300
```

Example Configuration:

```
supervisor@rtbrick>cbng1.rtbrick.net: cfg> show config forwarding-options address-
translation profile
{
  "rtbrick-config:profile": [
    {
      "profile": "nat_profile1",
      "pool": "nataddr_pool1",
      "max-rules": "128",
      "ip-protocol": {
        "tcp": {
          "ageing-timeout": 600
        },
        "udp": {
          "ageing-timeout": 300
        },
        "other": {
          "ageing-timeout": 300
        }
      }
    }
  ]
}
```

NAT Pool Configuration

A NAT IP address pool includes a set of public IPv4 addresses that are used for network address translation. You can create multiple public IPv4 address pools and one pool includes a range of public IPv4 addresses. These pools allocate public

IPv4 addresses to subscribers during address translation. While configuring a pool, you can define the group of public IPv4 addresses belonging to that pool by specifying the lowest and highest IP addresses.

The system allows you to create multiple pools and define the association among them. You can define the 'next-pool-name' that takes over when the current pool gets exhausted with the IPv4 addresses. When one pool gets exhausted, the next pool takes over and starts serving the IP addresses to subscribers when the address translation occurs.



Static and dynamic IP pools cannot be configured simultaneously; they are mutually exclusive.

Syntax:

set forwarding-options address-translation pool <pool-name> <attribute> <value>

Attribute	Description
<pool-name>	Specify the name of the address pool.
ipv4-address	Specify both the highest and lowest IPv4 addresses in the range of IPv4 addresses for the pool.
ipv4-address high	Specify the highest IPv4 address in the address pool. You must specify the highest IP address in the range of IP addresses.
ipv4-address low	Specify the lowest IPv4 address in the address pool. You must specify the lowest IP address in the range of IP addresses.
next-pool-name	Specify the name of the next address pool that is to be used when the current address pool is allocated completely.

Example Configuration:

The following commands configure nataddr_pool1 as the NAT pool and nataddr_pool2 as the next pool.

It indicates NAT pool nataddr_pool1 contains a range of public IPv4 addresses from 100.100.100.1 to 100.100.100.5.

When the pool nataddr_pool1 has fully allocated its IPv4 addresses, the next pool named nataddr_pool2 will start allocating IPv4 addresses from its pool. The pool nataddr_pool2 includes a rage of IPv4 address from 100.100.101.1 to 100.100.101.150.

```
set forwarding-options address-translation pool nataddr_pool1
set forwarding-options address-translation pool nataddr_pool1 next-pool-name
nataddr_pool2
set forwarding-options address-translation pool nataddr_pool1 ipv4-address low
100.100.100.1
set forwarding-options address-translation pool nataddr_pool1 ipv4-address high
100.100.100.5
set forwarding-options address-translation pool nataddr_pool2 ipv4-address low
100.100.101.1
set forwarding-options address-translation pool nataddr_pool2 ipv4-address high
100.100.101.150
```

Example Configuration:

```
supervisor@rtbrick: cfg> show config forwarding-options address-translation pool
{
  "rtbrick-config:pool": [
    {
      "pool-name": "nataddr_pool1",
      "next-pool-name": "nataddr_pool2",
      "ipv4-address": {
        "low": "100.100.100.1",
        "high": "100.100.100.5"
      }
    },
    {
      "pool-name": "nataddr_pool2",
      "ipv4-address": {
        "low": "100.100.101.1",
        "high": "100.100.101.150"
      }
    }
  ]
}
```

NAT Rule Configuration

You can define NAT rules only for static NAT. A NAT rule defines a match condition and a corresponding action. After you specify NAT rules, each packet is matched with each NAT rule. If a packet matches the condition specified in a rule, then the action corresponding to that match occurs. Match rules govern how the translation

of private IPv4 addresses to public IPv4 addresses is performed.

With NAT rules, you can define how address translation is applied to traffic, and how to handle various protocols and data traffic, such as TCP and UDP, to ensure proper address translation and the mappings of private addresses to public addresses.

Rules also define how to handle inbound and outbound traffic, different protocols, and data traffic such as TCP and UDP for ensuring the proper address translation of traffic.



Configuration limit for NAT maximum rules per subscriber is 16,384.

Syntax:

set forwarding-options address-translation rule <rule-name> <attribute> <value>

Attribute	Description
<rule-name>	Specify the name of the rule.
ordinal <ordinal-value>	Specify the ordinal value. An ordinal value is a numerical representation that indicates its relative position or order.
ordinal <ordinal-value> instance	Specify the RBFS instance name.
ordinal <ordinal-value> ip-protocol [tcp/udp]	Specify the IP protocol, TCP or UDP.
ordinal <ordinal-value> local [ipv4-address/port]	Specify the private IPv4 address or port number that needs to be translated.
ordinal <ordinal-value> public [ipv4-address/port]	Specify the public IPv4 address. This public IP will be mapped with the private IP in the translation table.

Configuring NAT Service Profile

You must create a NAT service profile and attach the service profile with the access interface for enabling CGNAT on the interface.

Syntax:

set access service-profile <profile-name> <attribute> <value>

Attribute	Description
<profile-name>	Name of the service profile.
address-translation profile <profile>	Specify the profile name for the address translation.

The following configuration defines a service profile named nat_service. It associates the NAT profile named 'nat_profile1' to the 'nat_service' profile. It indicates any subscriber using this service profile will use the configuration defined in nat_profile1.

```
set access service-profile nat_service
set access service-profile nat_service address-translation profile nat_profile1
```

Example:

```
{
  "rtbrick-config:service-profile": [
    {
      "profile-name": "nat_service",
      "address-translation": {
        "profile": "nat_profile1"
      },
      "qos": {
        "profile": "subs-triple-play"
      }
    }
  ]
}
```

Enable NAT Service Profile on the Access Interface

It is required to attach the NAT service profile to the access interface for enabling address translation on the interface.

Syntax:

set access interface [double-tagged | single-tagged | untagged]

```
<interface-name> <outer-vlan-min> <outer-vlan-max> <inner-vlan-min>
<inner-vlan-max> service-profile-name <service-profile-name>
```

Attribute	Description
service-profile	Configure global service profile.
<outer-vlan-min>	Specify the minimum number of outer VLANs. Allowed range: 1 - 4094.
<outer-vlan-max>	Specify the maximum number of outer VLANs. Allowed range 1 - 4094.
<inner-vlan-min>	Specify the minimum number of inner VLANs. Allowed range: 1 - 4094.
<inner-vlan-max>	Specify the maximum number of inner VLANs. Allowed range 1 - 4094.
service-profile-name	Specify the name of the service profile.

The following commands attach service profile nat_service to the interface (double-tagged) ifp-0/0/17. The configuration shows the range of outer VLANs as 1000 - 1007, and the range inner VLANs as 84 - 4084. The access type configured is IPoE and the service profile is NAT service. AAA profile name is ipoe-aaa and the gateway IFL is lo-0/0/0/100.

IPoE subscriber with outer VLAN between 1000 and 1007, and inner VLAN between 84 and 4084 will be matched with this NAT service profile and a corresponding action will be taken. Anything outside these vlans will not have any action from this NAT service profile.

```
set access interface double-tagged ifp-0/0/17 1000 1007 84 4084
set access interface double-tagged ifp-0/0/17 1000 1007 84 4084 access-type IPoE
set access interface double-tagged ifp-0/0/17 1000 1007 84 4084 access-profile-
name ipoe
set access interface double-tagged ifp-0/0/17 1000 1007 84 4084 service-profile-
name nat_service
set access interface double-tagged ifp-0/0/17 1000 1007 84 4084 aaa-profile-name
ipoe-aaa
set access interface double-tagged ifp-0/0/17 1000 1007 84 4084 gateway-ifl lo-
0/0/0/100
```

```
{
  "rtbrick-config:interface": {
    "double-tagged": [
      {
```

```
        "interface-name": "ifp-0/0/17",
        "outer-vlan-min": 1000,
        "outer-vlan-max": 1007,
        "inner-vlan-min": 84,
        "inner-vlan-max": 4084,
        "access-type": "IPoE",
        "access-profile-name": "ipoe",
        "service-profile-name": "nat_service",
        "aaa-profile-name": "ipoe-aaa",
        "gateway-ifl": "lo-0/0/0/100"
      }
    ]
  }
}
```

The following commands configure a double-tagged interface ifp-0/0/6 and outer VLAN minimum value is 1000, maximum value as 1007, inner VLAN minimum value as 84 and maximum value as 4084. The access type configured is PPPoE, service profile is NAT service. AAA profile name is configured as ipoe-aaa.

It indicates PPPoE subscriber with outer VLAN between 1000 and 1007, and inner VLAN between 84 and 4084 will be matched with this NAT service profile and a corresponding action will be taken. Anything outside these vlans will not have any action from this NAT service profile.

```
set access interface double-tagged ifp-0/0/16 1000 1007 84 4084
set access interface double-tagged ifp-0/0/16 1000 1007 84 4084 access-type PPPoE
set access interface double-tagged ifp-0/0/16 1000 1007 84 4084 access-profile-
name pppoe
set access interface double-tagged ifp-0/0/16 1000 1007 84 4084 service-profile-
name nat_service
set access interface double-tagged ifp-0/0/16 1000 1007 84 4084 aaa-profile-name
ipoe-aaa
```

Example:

```
{
  "rtbrick-config:interface": {
    "double-tagged": [
      {
        "interface-name": "ifp-0/0/16",
        "outer-vlan-min": 1000,
        "outer-vlan-max": 1007,
        "inner-vlan-min": 84,
        "inner-vlan-max": 4084,
        "access-type": "PPPoE",
        "access-profile-name": "pppoe",
        "service-profile-name": "nat_service",
        "aaa-profile-name": "ipoe-aaa"
      },
    ]
  }
```

```
}
```

Enable NAT on an Instance

You can enable address translation for a specific routing instance such as VRF or virtual router rather than globally across the entire router.

Syntax:

set instance <instance-name> **address-translation true**

Attribute	Description
<instance-name>	Name of the instance.

The following command is used to enable address translation for the instance named 'vrf1'.

```
set instance vrf1 address-translation true
```

```
supervisor@rtbrick.net: op> show config instance vrf1 address-translation
{
  "rtbrick-config:address-translation": "true"
}
```

Enable NAT on External Interface

It is required to enable the NAT on the external (core-facing) interface.

Syntax:

set interface <interface-name> **unit** <unit-id> **address-translation direction** <public>

Attribute	Description
<interface-name>	Name of the interface.
<unit-id>	Configure the number of sub-interfaces under the physical interface.

Attribute	Description
public	Specify 'public' for the external interface.

The following commands configure the external interface ifp-0/1/64 for IPv4 address translation. 'Unit' logical identifier for this physical interface. Direction 'public' shows the configuration on external interface for address translation.

```
set interface ifp-0/1/64 unit 100
set interface ifp-0/1/64 unit 100 address-translation
set interface ifp-0/1/64 unit 100 address-translation direction public
```

```
supervisor@rtbrick.net: cfg> show config interface ifp-0/1/64 unit 100
{
  "rtbrick-config:unit": [
    {
      "unit-id": 100,
      "address-translation": {
        "direction": "public"
      }
    }
  ]
}
```

Enable Logging for NAT

You can optionally enable logging for CGNAT operations.



All RBFS logs and related information is available in the *RBFS Logging User Guide*. For the list of RBFS logs, see Log Reference.

set log bd <name> <options>

Attribute	Description
level	Specify the log level.
module	Specify the log module.
plugin-alias	Specify the plugin-alias URL. Plugin-alias is an external logging host server to which you can export logs. For example, Graylog.

The following commands configure logging for NAT module natd with a log level 'debug'.

```
set log bd natd
set log bd natd module nat
set log bd natd module nat level debug
```

```
supervisor@rtbrick.net: cfg> show config log bd natd
{
  "rtbrick-config:bd": [
    {
      "bd-name": "natd",
      "module": [
        {
          "module-name": "nat",
          "level": "debug"
        }
      ]
    }
  ]
}
```

Enabling NAT ACL Support for ICMP and TCP Control Messages

You can enable Access Control Lists support for ICMP and TCP Control messages.

Enabling NAT Support for ICMP Using ACLs

The NAT ACLs for ICMP packets allows address translation for ICMP request and response packets through the use of Access Control Lists (ACLs). This enhances the handling of ICMP traffic by providing precise control over NAT behavior for ICMP packets.



Setting up the NAT ACLs for ICMP will be handled by the NAT application with the 25.1.1 release, eliminating the need for manual configuration.

set forwarding-options acl l3v4 rule rule-name> ordinal <ordinal-number> <attribute > <value>

Attribute	Description
<rule-name>	Specify the name of the rule.
ordinal <ordinal-value>	Specify the ordinal value. An ordinal value is a numerical representation that indicates its relative position or order.

Attribute	Description
match	Define the conditions under which the rule will be applied. These conditions determine which packets the rule should act on.
action	Defines what happens to packets that match the rule's criteria.
priority	Determines the priority of the rule when multiple rules with the same ordinal value are evaluated.
direction	The rule applies to ingress or egress traffic.

Example commands:

```
set forwarding-options acl l3v4 rule NAT_TRAP
set forwarding-options acl l3v4 rule NAT_TRAP ordinal 1001
set forwarding-options acl l3v4 rule NAT_TRAP ordinal 1001 match direction ingress
set forwarding-options acl l3v4 rule NAT_TRAP ordinal 1001 match ip-protocol icmp
set forwarding-options acl l3v4 rule NAT_TRAP ordinal 1001 match destination-ipv4-
prefix-list PREFIXES_NAT_PUBLIC
set forwarding-options acl l3v4 rule NAT_TRAP ordinal 1001 action trap nat
set forwarding-options acl l3v4 rule NAT_TRAP ordinal 1001 priority 1001

set forwarding-options acl l3v4 rule NAT_TRAP ordinal 1002
set forwarding-options acl l3v4 rule NAT_TRAP ordinal 1002 match direction ingress
set forwarding-options acl l3v4 rule NAT_TRAP ordinal 1002 match source-ipv4-
prefix 100.64.0.0/10
set forwarding-options acl l3v4 rule NAT_TRAP ordinal 1002 match ip-protocol icmp
set forwarding-options acl l3v4 rule NAT_TRAP ordinal 1002 action trap nat
set forwarding-options acl l3v4 rule NAT_TRAP ordinal 1002 priority 1002
```

Example:

```
supervisor@rtbrick.net: cfg> show config forwarding-options acl l3v4
{
  "rtbrick-config:l3v4": {
    "rule": [
      {
        "rule-name": "NAT_TRAP",
        "ordinal": [
          {
            "ordinal-value": 1001,
            "match": {
              "direction": "ingress",
              "ip-protocol": "icmp",
              "destination-ipv4-prefix-list": "PREFIXES_NAT_PUBLIC"
            },
            "action": {
              "trap": "nat"
            },
            "priority": 1001
```

```
          },
          {
            "ordinal-value": 1002,
            "match": {
              "direction": "ingress",
              "source-ipv4-prefix": "100.64.0.0/10",
              "ip-protocol": "icmp"
            },
            "action": {
              "trap": "nat"
            },
            "priority": 1002
          }
        ]
      }
    ]
      }
    }
```

The preceding configuration defines Layer 3 IPv4 Access Control List (ACL) rules for managing ICMP traffic. The rule with the ordinal value 1001 is designed to redirect ICMP traffic for Network Address Translation (NAT) processing based on specific criteria. The ACL rule is named NAT_TRAP.

The matching criteria for this rule include the direction of traffic, which is set to ingress. This means the rule applies only to incoming traffic. The specified protocol is ICMP, indicating that the rule is applicable to ICMP packets.

The 'destination-ipv4-prefix-list' is designated as PREFIXES_NAT_PUBLIC, which is a predefined list containing a range of IPv4 addresses. The rule specifically pertains to ICMP packets whose destination IP is included in the PREFIXES_NAT_PUBLIC list. These rules ensure that ICMP packets requiring NAT handling are identified and appropriately redirected to the NAT process. When an ICMP packet that meets the conditions (ingress, ICMP, and a destination in PREFIXES_NAT_PUBLIC) is detected, it is redirected (or punted) to the NAT process for further handling.

Enabling NAT Support for TCP Control Messages Using ACL

This configuration enables address translation on TCP control messages through ACLs. The feature supports control messages such as FIN, SYN, and RST. It applies functionality to TCP control messages such as fin-ack and rst-ack.



Setting up the NAT ACLs for TCP control messages will be handled by the NAT application with the 25.1.1 release, eliminating the need for manual configuration.

Syntax:

set forwarding-options acl l3v4 rule <rune-name> **ordinal** <ordinal-number> **match tcp-control** [fin-ack | rst-ack]

Attribute	Description
<rule-name>	Specify the name of the rule.
ordinal <ordinal-value>	Specify the ordinal value. An ordinal value is a numerical representation that indicates its relative position or order.
match	Define the conditions under which the rule will be applied. These conditions determine which packets the rule should act on.
action	Defines what happens to packets that match the rule's criteria.
priority	Determines the priority of the rule when multiple rules with the same ordinal value are evaluated.
direction	The rule applies to ingress or egress traffic.
tcp-control <fin-ack>	Matches TCP packets with the FIN-ACK control flag set. Note: When using the tcp-control match attribute in a match rule, it is necessary to explicitly configure match ip-protocol for TCP. This ensures that the rule accurately identifies and processes TCP packets before applying any matching for TCP control flags.
destination-ipv4-prefix-list	Name of the prefix list. The list includes predefined destination IP addresses.

Example commands:

```
set forwarding-options acl l3v4 rule NAT_TRAP ordinal 1003
set forwarding-options acl l3v4 rule NAT_TRAP ordinal 1003 match direction ingress
set forwarding-options acl l3v4 rule NAT_TRAP ordinal 1003 match tcp-control fin-
ack
set forwarding-options acl l3v4 rule NAT_TRAP ordinal 1003 match destination-ipv4-
prefix-list PREFIXES_NAT_PUBLIC
set forwarding-options acl l3v4 rule NAT_TRAP ordinal 1003 action trap nat
set forwarding-options acl l3v4 rule NAT_TRAP ordinal 1003 priority 1003
set forwarding-options acl l3v4 rule NAT_TRAP ordinal 1004
set forwarding-options acl l3v4 rule NAT_TRAP ordinal 1004 match direction ingress
```

```
set forwarding-options acl l3v4 rule NAT_TRAP ordinal 1004 match source-ipv4-
prefix 100.64.0.0/10
set forwarding-options acl l3v4 rule NAT_TRAP ordinal 1004 match tcp-control fin-
ack
set forwarding-options acl l3v4 rule NAT_TRAP ordinal 1004 action trap nat
set forwarding-options acl l3v4 rule NAT_TRAP ordinal 1004 priority 1004
set forwarding-options acl l3v4 rule NAT_TRAP ordinal 1005
set forwarding-options acl l3v4 rule NAT_TRAP ordinal 1005 match direction ingress
set forwarding-options acl l3v4 rule NAT_TRAP ordinal 1005 match tcp-control rst-
ack
set forwarding-options acl l3v4 rule NAT_TRAP ordinal 1005 match destination-ipv4-
prefix-list PREFIXES_NAT_PUBLIC
set forwarding-options acl l3v4 rule NAT_TRAP ordinal 1005 action trap nat
set forwarding-options acl l3v4 rule NAT_TRAP ordinal 1005 priority 1005
set forwarding-options acl l3v4 rule NAT_TRAP ordinal 1006
set forwarding-options acl l3v4 rule NAT_TRAP ordinal 1006 match direction ingress
set forwarding-options acl l3v4 rule NAT_TRAP ordinal 1006 match source-ipv4-
prefix 100.64.0.0/10
set forwarding-options acl l3v4 rule NAT_TRAP ordinal 1006 match tcp-control rst-
ack
set forwarding-options acl l3v4 rule NAT_TRAP ordinal 1006 action trap nat
set forwarding-options acl l3v4 rule NAT_TRAP ordinal 1006 priority 1006
```

Example:

```
supervisor@rtbrick.net: cfg> show config forwarding-options acl l3v4
{
  "rtbrick-config:l3v4": {
    "rule": [
      {
        "rule-name": "NAT_TRAP",
        "ordinal": [
          {
            "ordinal-value": 1003,
            "match": {
              "direction": "ingress",
              "tcp-control": "fin-ack",
              "destination-ipv4-prefix-list": "PREFIXES_NAT_PUBLIC"
            },
            "action": {
              "trap": "nat"
            },
            "priority": 1003
          },
          {
            "ordinal-value": 1004,
            "match": {
              "direction": "ingress",
              "source-ipv4-prefix": "100.64.0.0/10",
              "tcp-control": "fin-ack"
            },
            "action": {
              "trap": "nat"
            },
            "priority": 1004
          },
          {
            "ordinal-value": 1005,
            "match": {
```

```
              "direction": "ingress",
              "tcp-control": "rst-ack",
              "destination-ipv4-prefix-list": "PREFIXES_NAT_PUBLIC"
            },
            "action": {
              "trap": "nat"
            },
            "priority": 1005
          },
          {
            "ordinal-value": 1006,
            "match": {
              "direction": "ingress",
              "source-ipv4-prefix": "100.64.0.0/10",
              "tcp-control": "rst-ack"
            },
            "action": {
              "trap": "nat"
            },
            "priority": 1006
          }
        ]
      }
    ]
  }
}
```

The preceding configuration defines ACL for Layer 3 IPv4 traffic. The ACL is named NAT_TRAP and consists of multiple rules that match specific traffic patterns and apply a 'trap' action to punt the traffic for further NAT processing. Each rule is identified by an ordinal value.

Match Criteria includes direction which is specified as ingress. All rules are applied to ingress traffic. Protocol is defined as TCP traffic with specific control flags: fin-ack, rst-ack, and rst.

In the configuration:

- Ordinal 1003 matches TCP traffic with the fin-ack flag and a destination IP in the PREFIXES_NAT_PUBLIC list.
- Ordinal 1004 matches TCP traffic with the fin-ack flag and a source IP in the 100.64.0.0/10 range.
- Ordinal 1005 matches TCP traffic with the rst-ack flag and a destination IP in the PREFIXES_NAT_PUBLIC list.
- Ordinal 1006 matches TCP traffic with the rst-ack flag and a source IP in the 100.64.0.0/10 range.

Modifying the Policer on NAT Trap

You can modify a 'policer' associated with NAT traps, which directs certain packets to the control plane (hostpath). A NAT trap indicates when a device is performing network address translation, some packets that require special handling, are diverted to the control plane for processing.

To change the policer for NAT traps, use the following command:

Syntax:

set forwarding-options address-translation trap policer <policer-name>

Attribute	Description
<policer-name>	Specify the name of the policer.

Example for modifying the policer for NAT trap.

```
set forwarding-options address-translation trap policer _DEFAULT_POLICER_5_MB
```

Selective NAT Bypass Using Destination Prefix

RBFS CGNAT allows selective bypass of Network Address Translation based on destination IPv4 prefixes using an L3 ACL rule. Traffic matching the configured prefix in the specified direction is excluded from address translation. This feature enables you to preserve original source and destination addresses for specific networks.

Syntax

set forwarding-options acl l3v4 rule <name> **ordinal** <value> **match destination-ipv4-prefix** <prefix>
set forwarding-options acl l3v4 rule <name> **ordinal** <value> **match direction ingress**
set forwarding-options acl l3v4 rule <name> **ordinal** <value> **action trap default**
set forwarding-options acl l3v4 rule <name> **ordinal** <value> **priority**

```
<value>
```

The following configuration defines a rule named 'exclude_nat' with an ingress match condition. The rule matches traffic destined to the 10.10.10.1/24 prefix and assigns it a priority of 500 for processing order. Matching packets are trapped to the default control-plane handler, allowing the system to process them separately for excluding them from NAT handling.

```
set forwarding-options acl l3v4 rule exclude_nat
set forwarding-options acl l3v4 rule exclude_nat ordinal 1
set forwarding-options acl l3v4 rule exclude_nat ordinal 1 match destination-ipv4-
prefix 10.10.10.1/24
set forwarding-options acl l3v4 rule exclude_nat ordinal 1 match direction ingress
set forwarding-options acl l3v4 rule exclude_nat ordinal 1 action trap default
set forwarding-options acl l3v4 rule exclude_nat ordinal 1 priority 500
```

```
{
  "rtbrick-config:acl": {
    "l3v4": {
      "rule": [
        {
          "rule-name": "exclude_nat",
          "ordinal": [
            {
              "ordinal-value": 1,
              "match": {
                "destination-ipv4-prefix": "10.10.10.1/24",
                "direction": "ingress"
              },
              "action": {
                "trap": "default"
              },
              "priority": 500
            }
          ]
        }
      ]
    }
  }
}
```

Selective NAT Bypass for Subscribers Using ACLs

For information about match condition, action, prefix list configurations, see the following sections:

- Configuring ACL Match Criteria
- Configuring ACL Actions

- Configuring Prefix Lists

Example:

This configuration defines an ACL rule named 'override_nat' to selectively control NAT behavior for specific subscribers. The rule is assigned ordinal '1' and it matches ingress traffic, meaning packets are evaluated as they enter the device. The match condition uses a prefix list called 'NON_NAT_SUBS', which contains the IPv4 address range 192.0.2.0/24 and 198.51.100.0/24. Any packet with a source IP belonging to these range will match the rule.

The configured action 'trap default' redirects matching packets to the control plane. This overrides the default NAT processing behavior. As a result, traffic from these specified prefix list is excluded from NAT.



The source IPv4 address space must be unique and must not share any address space with the public NAT pool addresses.

```
set forwarding-options acl l3v4 rule override_nat
set forwarding-options acl l3v4 rule override_nat ordinal 1
set forwarding-options acl l3v4 rule override_nat ordinal 1 match direction
ingress
set forwarding-options acl l3v4 rule override_nat ordinal 1 match source-ipv4-
prefix-list NON_NAT_SUBS
set forwarding-options acl l3v4 rule override_nat ordinal 1 action trap default
set forwarding-options prefix-list NON_NAT_SUBS
set forwarding-options prefix-list NON_NAT_SUBS ipv4-prefix 192.0.2.0/24
set forwarding-options prefix-list NON_NAT_SUBS ipv4-prefix 198.51.100.0/24
```

```
"rtbrick-config:forwarding-options": {
      "acl": {
        "l3v4": {
          "rule": [
            {
              "rule-name": "override_nat",
              "ordinal": [
                {
                  "ordinal-value": 1,
                  "match": {
                    "direction": "ingress",
                    "source-ipv4-prefix-list": "NON_NAT_SUBS"
                  },
                  "action": {
                    "trap": "default"
                  }
                }
              ]
            }
          ]
        }
```

```
      },
      "prefix-list": [
        {
          "prefix-list-name": "NON_NAT_SUBS",
          "ipv4-prefix": [
            {
              "ipv4-prefix": "192.0.2.0/24"
            },
            {
              "ipv4-prefix": "198.51.100.0/24"
            }
          ]
        }
      ]
    },
```

5.3.3. Carrier Grade NAT Operational Commands

Carrier Grade NAT Show Commands

The CGNAT operational commands provide detailed information about the address translation operations.

NAT Pool Information

This command displays information about IPv4 address pool for a user.

Syntax:

show address-translation allocation <options>

Option	Description
pool	Specify the pool name.
user	Specify the user name.

Example for NAT pool allocation.

```
supervisor@rtbrick.net: cfg> show address-translation allocation pool
Pool: pool1
  Profile: nat_profile1
  Instance: vrf1
  Allocated: 100.00%
Pool: pool2
  Profile: nat_profile1
  Instance: vrf1
```

```
  Allocated: 100.00%
```

Example for allocation details for subscribers

```
supervisor@rtbrick.net: cfg> show address-translation allocation user
User                            Original Address     Translated Address   Port
Range
ppp-0/1/20/72339069014638594     10.100.128.1         100.100.100.100      14912 -
14975
ppp-0/1/20/72339069014638594     10.100.128.1         100.100.100.100      18944 -
19007
ppp-0/1/20/72339069014638595     10.100.128.3         100.100.100.101      14976 -
15039
ppp-0/1/20/72339069014638595     10.100.128.3         100.100.100.101      18880 -
18943
ppp-0/1/20/72339069014638596     10.100.128.5         100.100.100.101      15104 -
15167
ppp-0/1/20/72339069014638596     10.100.128.5         100.100.100.101      17856 -
17919
ppp-0/1/20/72339069014638597     10.100.128.7         100.100.100.100      15104 -
15167
ppp-0/1/20/72339069014638597     10.100.128.7         100.100.100.100      17792 -
17855
ppp-0/1/20/72339069014638598     10.100.128.9         100.100.100.101      15040 -
15103
ppp-0/1/20/72339069014638598     10.100.128.9         100.100.100.101      17792 -
17855
ppp-0/1/20/72339069014638599     10.100.128.11        100.100.100.100      15040 -
15103
```

NAT Rule Details

Syntax:

show address-translation rule <options>

Option	Description
-	Without any option, the command displays the information for all rules.
instance	Displays NAT rule information for the specified instance.
summary	Displays summary of the information for the NAT rule.
user	Displays user information for the NAT rule.

Example for address translation rule for an instance.

```
supervisor@rtbrick.net: cfg> show address-translation rule instance default
Instance: default
User                              Protocol   Original Address        Translated
Address      Direction
ipoe-0/0/18/216454257090494481   tcp        11.100.128.24, 60011    100.100.100.1,
1048     Both
ppp-0/0/17/72339069014638604     tcp        11.100.128.25, 60011    100.100.100.2,
1034     Both
ipoe-0/0/18/216454257090494481   tcp        11.100.128.24, 60012    100.100.100.1,
1049     Both
ppp-0/0/17/72339069014638604     tcp        11.100.128.25, 60012    100.100.100.2,
1035     Both
ipoe-0/0/18/216454257090494481   tcp        11.100.128.24, 60013    100.100.100.1,
1050     Both
ppp-0/0/17/72339069014638604     tcp        11.100.128.25, 60013    100.100.100.2,
1036     Both
ipoe-0/0/18/216454257090494481   tcp        11.100.128.24, 60014    100.100.100.1,
1051     Both
ppp-0/0/17/72339069014638604     tcp        11.100.128.25, 60014    100.100.100.2,
1037     Both
ipoe-0/0/18/216454257090494481   tcp        11.100.128.24, 60015    100.100.100.1,
1052     Both
ppp-0/0/17/72339069014638604     tcp        11.100.128.25, 60015    100.100.100.2,
1038     Both
ipoe-0/0/18/216454257090494481   tcp        11.100.128.24, 60016    100.100.100.1,
1053     Both
ppp-0/0/17/72339069014638604     tcp        11.100.128.25, 60016    100.100.100.2,
1039     Both
ipoe-0/0/18/216454257090494481   tcp        11.100.128.24, 60017    100.100.100.1,
1054     Both
ppp-0/0/17/72339069014638604     tcp        11.100.128.25, 60017    100.100.100.2,
1040     Both
ipoe-0/0/18/216454257090494481   tcp        11.100.128.24, 60018    100.100.100.1,
1024     Both
ppp-0/0/17/72339069014638604     tcp        11.100.128.25, 60018    100.100.100.2,
1041     Both
ipoe-0/0/18/216454257090494481   tcp        11.100.128.24, 60019    100.100.100.1,
1025     Both
ppp-0/0/17/72339069014638604     tcp        11.100.128.25, 60019    100.100.100.2,
1042     Both
ipoe-0/0/18/216454257090494481   tcp        11.100.128.24, 60020    100.100.100.1,
1026     Both
```

Example for address translation rule summary. The example summary shows the total number of NAT rules for TCP flows.

```
supervisor@rtbrick.net: cfg> show address-translation rule summary
Instance: default
  Source     Protocol      Rules
  Dynamic    tcp              62
  Total Dynamic Rules         62
```

Example for address translation rules for subscribers.

```
supervisor@rtbrick: cfg> show address-translation rule
```

```
Instance: vrf1
User                              Protocol   Original Address        Translated
Address      Direction
ipoe-0/1/21/216454257090494746   tcp        11.100.129.0, 65001
100.100.100.101, 36874  Both
ipoe-0/1/21/216454257090494975   tcp        11.100.130.0, 65001
100.100.100.101, 60170  Both
ipoe-0/1/21/216454257090495232   tcp        11.100.131.0, 65001
100.100.101.101, 38730  Both
ppp-0/1/20/72339069014638594     tcp        10.100.128.1, 65001
100.100.100.100, 14914  Both
ipoe-0/1/21/216454257090494501   tcp        11.100.128.1, 65001
100.100.100.100, 2122   Both
ppp-0/1/20/72339069014638722     tcp        10.100.129.1, 65001
100.100.100.100, 19924  Both
ipoe-0/1/21/216454257090494747   tcp        11.100.129.1, 65001
100.100.100.100, 36746  Both
```

The example summary shows the total number of NAT rules for other protocol flows:

```
supervisor@rtbrick.net: cfg> show address-translation rule
Instance: vrf1
User                              Protocol   Original Address        Translated
Address      Direction
ipoe-0/1/30/216454257090494465   icmp       10.100.128.1, 7684
100.100.100.100, 1024   Both
```

NAT Trap Statistics

Syntax:

```
show address-translation trap statistics
```

This command displays the information of packets trapped in the NAT daemon.

Example for TCP flow stats

```
supervisor@rtbrick: cfg> show address-translation trap statistics
Protocol   Flags                     Status             Count
tcp        -|syn|-|-|-|-|-|-|-       Success           152958
tcp        -|syn|-|-|-|-|-|-|-       Failure            23186
Total Successful Traps:                                152958
Total Failed Traps:                                     23186
```

Example for other flow (ICMP) stats:

```
supervisor@rtbrick.net: cfg> show address-translation trap statistics
Protocol   Flags                     Status             Count
other      -|-|-|-|-|-|-|-|-         Success               50
Total Successful Traps:                                    50
Total Failed Traps:                                         0
```

NAT Error Details

This command displays NAT error information.

Syntax:

show address-translation error

Example for address translation error

```
supervisor@rtbrick.net: cfg> show address-translation error
INSTANCE - Packet Table
    Counter        : 4
    Current Update : Thu May 02 10:05:52 GMT +0000 2024
    Last Update    : Thu May 02 10:05:52 GMT +0000 2024
POOL_CFG - Pool Flush
    Counter        : 1
    Current Update : Thu May 02 10:05:43 GMT +0000 2024
    Last Update    : Thu May 02 10:05:43 GMT +0000 2024
```

Clear NAT Errors

Syntax

clear address-translation error

This command resets the existing statistics for NAT errors.

5.4. RBFS Carrier-Grade Network Address Translation Appliance

5.4.1. CGNAT Appliance Overview

Carrier-Grade Network Address Translation (CGNAT) appliance is a technology

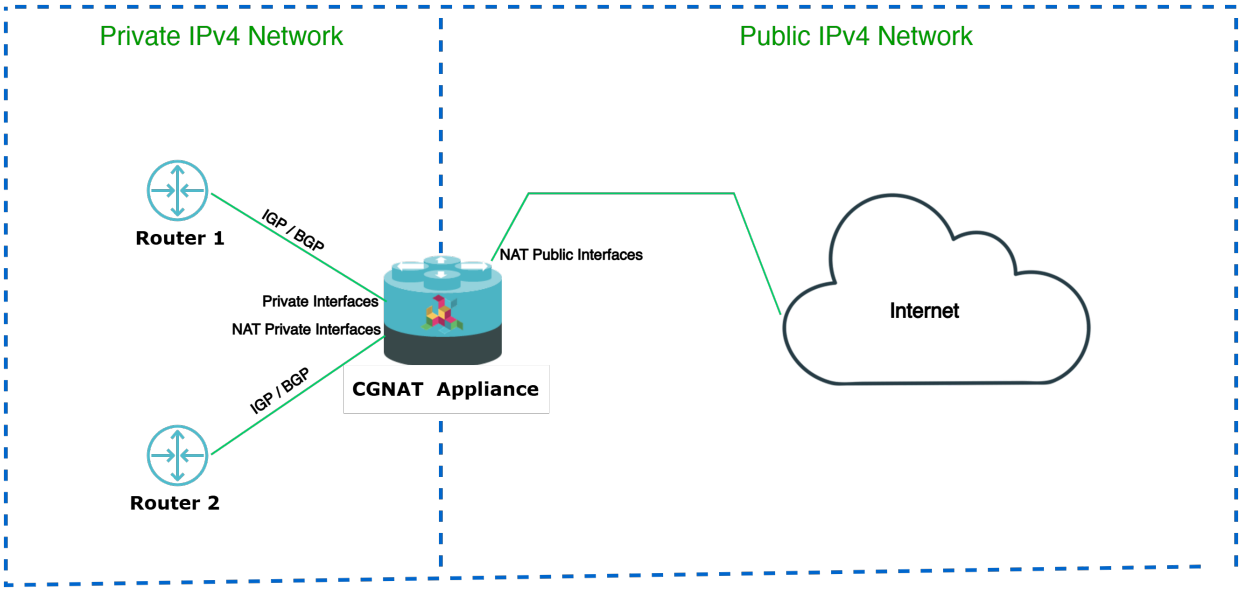
solution that addresses the IPv4 exhaustion challenge of service providers. The solution helps to use private network addresses and to limit the use of publicly routable IPv4 addresses significantly.

The main features of the CGNAT appliance are:

- Private Network Routers, such as BNGs, establish reachability within private networks and direct upstream traffic (from the private network to the internet) through a centralized CGNAT appliance. The CGNAT appliance is configured with NAT profiles, public pools, and separate private/public interfaces.
- Downstream reachability is achieved via aggregate NAT routes programmed by the CGNAT appliance and redistributed to BGP peers.
- Upstream reachability involves routers (Router 1 / Router 2 as shown in the diagram below) advertising private pool aggregate routes to the CGNAT appliance.
- Traffic received at CGNAT private interfaces undergoes NAT treatment (SNAT).
- NAT Traffic received at CGNAT public interfaces undergoes NAT treatment(DNAT) and forwarded to the destination, while non-NAT IP traffic is forwarded seamlessly.

The following diagram illustrates a high-level view of CGNAT appliance.

CGNAT Overview



There are three basic concepts in address translation:

Static NAT

Static NAT associates one private IP address, IP-protocol and source-L4-port with public IP address, IP protocol and source-L4-port. This is a one-to-one mapping and you must manually define the mapping between a private and public address and port (UDP/TCP).

Dynamic NAT

In Dynamic NAT, internal private IPv4 addresses and ports are mapped with a public IPv4 address and port, and this happens dynamically. The router dynamically picks an address from the address pool that is not currently assigned.

NAT444

CGNAT appliance supports NAT444. NAT 444 refers to three sets of IPv4 addresses: Customer private, ISP private, and public Internet. Network address translation occurs from customer private to ISP private, and then ISP private to public. The NAT444, also known as CGNAT, functionality maps IPv4 subscriber private addresses to IPv4 public addresses.

Benefits of CGNAT Appliance

CGNAT appliance allows service providers to provide services to a large number of their subscribers using a limited number of public IPv4 addresses. The benefits include:

Conserve Public IPv4 Addresses

The solution helps service providers conserve expensive public IPv4 addresses by enabling multiple subscribers to share a single public IPv4 address. With CGNAT, one public IPv4 address can manage hundreds of devices within the private network. It reduces the requirement of continually buying additional public IP addresses.

Enhanced Security

In addition to stretching the limited pool of public IPv4 addresses even further, CGNAT also provides significant security benefits. It helps to enhance network security by keeping the internal addressing private from the external network. It makes it difficult for attackers to target specific devices on the network by preventing attacks that target specific IP addresses.

Performance at Carrier-Grade

CGNAT appliance solution implements the functions of IPv4 address translation in the network of service providers. Service providers can deploy NAT in a way that allows multiple traffic flows on an L3 interface to share a single global IPv4 address and scale to several thousands of address translations. CGNAT operations are implemented at the forwarding plane (hardware level) to ensure optimal performance. This hardware-level implementation achieves high throughput with no performance impact and packet processing occurs without overburdening the CPU. The solution offers carrier-grade scalability with fast translation rates and a large number of IPv4 address and port number translations.

Understanding CGNAT Appliance Implementation

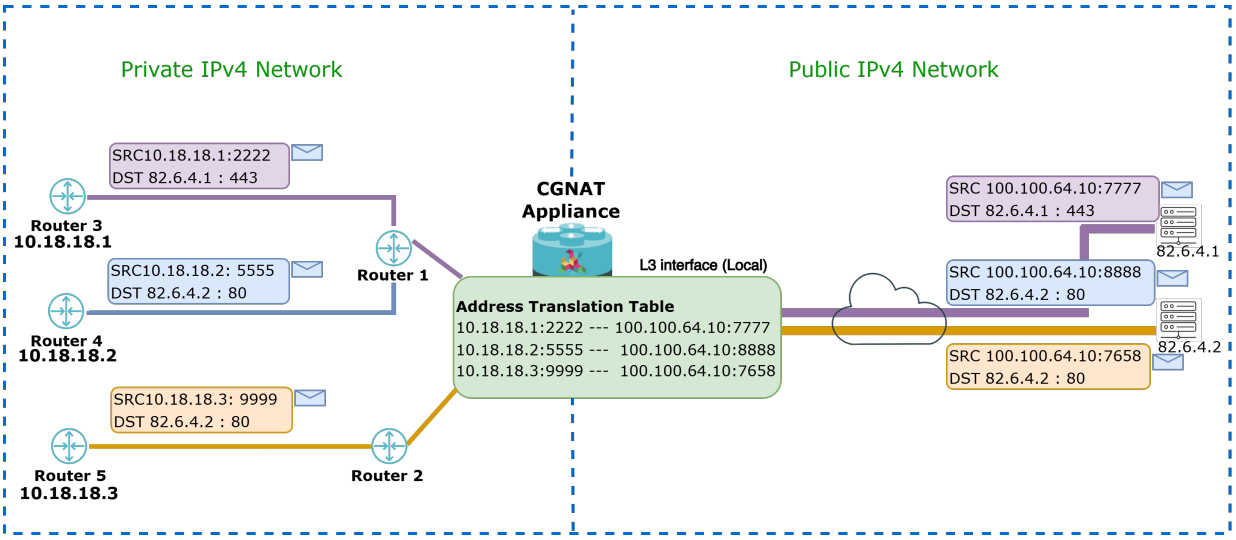
CGNAT appliance solution has been designed to support Port Address Translation, also known as Network Address Port Translation (NAPT), which has the greatest potential to conserve IPv4 addresses for service providers. NAPT is known as an effective method to allow multiple devices to connect to the Internet using a single public IPv4 address.

Network Address Port Translation

Network Address Port Translation is a dynamic NAT in which port numbers along with IP address are used to identify which traffic belongs to which private IP address. CGNAT appliance translates the source private IPv4 address and port number to a public source IPv4 address and unique port number. This allows multiple devices with different private IP addresses to use a single public IPv4 address. The unique port number ensures that the traffic is delivered to the correct device.

The following diagrams illustrate how CGNAT appliance works at a high level.

CGNAT Traffic



The diagram shows three subscribers using private IPv4 addresses (10.18.18.1, 10.18.18.2, and 10.18.18.3 send traffic to two different servers (82.6.4.1 and 82.6.4.2) on the public network.

CGNAT performs the address translation by replacing the source private IPv4 address with the public IPv4 address from the address pool and the source port number with a unique port number. After the address translation, the device forwards the traffic to the destination servers. After the translation, packets have a new source IPv4 address which is the public IPv4 and a unique port number as per the mapping in the address translation table.

CGNAT maintains a translation table with the entries. Entries are records of mapped private IPv4 addresses and port numbers with the public IPv4 addresses and port numbers.

The downstream traffic from the servers traverses to the CGNAT device. The packets coming from external hosts include the destination address as the (translated) public IPv4 address. CGNAT device performs reversal address translation for these packets as per the translation table mapping for the downstream traffic.

NAPT helps to significantly reduce the number of logs generated as it generates logs only during the allocation and release of each block of ports.

Deterministic NAT

CGNAT appliance offers support for deterministic NAT mode, which provides a consistent mapping of private IPv4 addresses with public IPv4 addresses and port ranges. This mode ensures a one-to-one mapping of private IPv4 addresses with

public IPv4 addresses, allowing you to specify the private address and its matching public address and port range. The given private IPv4 address is always translated to the same public address.

In addition, deterministic NAT guarantees a predetermined and fixed translation for a given internal address with a public IPv4 and port combination, ensuring consistency and stability in the mapping. This feature is particularly useful for applications that involve security protocols, as well as for service providers who need to track private L3 interface traffic flows.

Furthermore, deterministic NAT significantly reduces address translation logs, as private IPv4 addresses are always mapped to public IPv4 addresses and port ranges.

Address Translation Table

Port mapping is a feature that allows multiple devices to share the same public IPv4 address with different port numbers. CGNAT generates a unique port number for each traffic flow on the L3 interface. Port mapping helps to determine the correct host among the many devices in the private network that use the same public IPv4 address.

CGNAT appliance maintains an address translation table that maps private IPv4 addresses and port numbers to their corresponding public IPv4 addresses and ports. Whenever an incoming packet arrives, CGNAT checks the translation table to see if a translation entry exists for that packet. If there’s an entry, the CGNAT replaces the source IPv4 address and port number in the packet header with the mapped public IPv4 address and port number.

When a device on the Internet sends packets downstream, the CGNAT software uses the translation table for address translation reversal. It replaces the destination public IPv4 address and port number in the packet header with the corresponding private IPv4 address and port number.

NAT IP Pools and Chaining

A NAT pool contains a range of multiple public IP addresses. You can create multiple pools and associate them with a NAT service. Pool chaining is a method in which you can associate one pool with another. For a pool, you can define 'next pool name'; so that when the pool gets exhausted with the IPv4 addresses, the next pool that is defined will take over.

Ageing

Ageing refers to the time that a translation entry exists or remains in the address translation table after it was last used.

The entries in the translation table have a finite lifespan as the software implements mechanisms to handle session timeouts.

When a host sends a packet to a destination, CGNAT translates the private IPv4 address and port to a public IPv4 address and port. This mapping is recorded as an entry in the address translation table. The software always looks up the translation table whenever it receives a packet to verify that any entry exists for the packet in the translation table. The software performs the address translation based on the recorded entries and its associated mappings for both inbound and outbound packets.

If there is no activity related to a specific mapping (for example, when there are no incoming or outgoing packets), the mapping will eventually be removed from the address translation table, once idle or unused entries are detected, entries removed from the address translation table to free up resources for the new upcoming traffic flows.

For TCP, idle or unused flows are typically detected by the receipt of TCP FIN-ACK packets, which indicate that both sides of the connection have finished sending data. Once detected, these flows are removed after a configurable aging timer expires.

For UDP, as it is a connectionless protocol, idle or unused flows are detected by periodically polling the flow traffic. As the number of UDP traffic flows increases, the idle flow detection mechanism also increases, ensuring that idle flows are removed in a timely manner. The aging of UDP flows is proportional to the number of traffic flows.

```
NOTE: The NAT ageing timeout is 200 seconds for TCP and UDP traffic. The actual
time taken to flush aged-out NAT rules depends on the number of NAT rules and the
number of counters.
```

Logging

CGNAT Appliance provides traffic monitoring capabilities to track and log network activities. You can enable logging for CGNAT operations.

Logging is not completely supported on CGNAT Appliance.

CGNAT Handling of ICMP Messages

The NAT-enabled RBFS devices can perform network address translation for ICMP echo request and reply messages. Use the ping command (ICMP Echo Request, Echo Reply) to check internet connectivity to external internet addresses when NAT is enabled. This feature is enabled by default.

CGNAT Handling of TCP Control Messages

RBFS with NAT supports address translation for TCP control messages using ACLs. It includes the TCP control messages such as FIN, FIN-ACK, RST, RST-ACK, SYN, and SYN-ACK. This feature is enabled by default.

CGNAT Support for Traceroute

The RBFS CGNAT provides support for Traceroute and critical ICMP error handling on certain platforms. This feature ensures that diagnostic tools can function correctly across NAT boundaries by accurately translating and forwarding "TTL Exceeded" and "Fragmentation Needed" messages.

Guidelines and Limitations

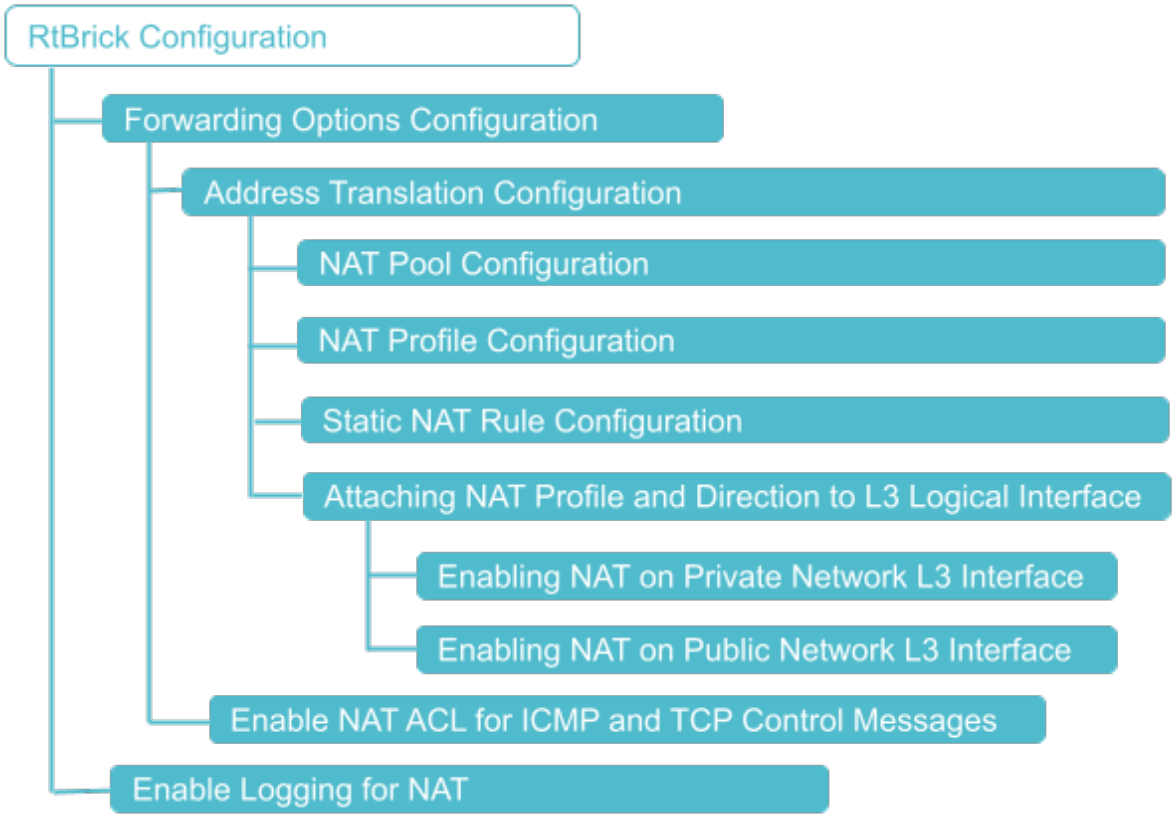
- Before configuring CGNAT, ensure that the correct platform profile is configured. Reboot the system for the changes to take effect, after setting the platform profile. For information about Platform Profile configuration, see Platform Profile.

Supported Platforms

Not all features are necessarily supported on each hardware platform. Refer to the *Platform Guide* for the features and the sub-features that are or are not supported by each platform.

5.4.2. CGNAT Appliance Configuration

Configuration Hierarchy



Prerequisites

Before configuring CGNAT, ensure that the appropriate platform profile is configured on the device. The platform profile determines the operating mode of the system and enables the required hardware resources for NAT functionality.

Configure one of the following platform profiles based on the deployment type:

- Use nat_1q or nat_4q profile when the system operates as a RBFS CGNAT, where NAT is integrated with subscriber management.
- Use this nat_standalone profile when the system operates as a dedicated CGNAT appliance without BNG subscriber functionality.

The platform profile must be configured and the system must be rebooted before proceeding with the CGNAT configuration.

Reboot the system for the changes to take effect, after setting the platform profile. For information about Platform Profile configuration, see Platform Profile.

CGNAT Appliance Configuration

You must perform the following tasks to configure CGNAT appliance.

1. Configure NAT Pool
2. Configure NAT Profile
3. Enable NAT on an Instance
4. Attaching NAT Profile and Direction to L3 Logical Interface
5. Enable NAT on Private Network L3 Interface
6. Enable NAT on Public Network L3 Interface
7. Configure NAT Rule
8. Enable Logging for NAT
9. Enable NAT ACL Support for ICMP and TCP Control Messages

Configuration Syntax and Commands

The following sections describe the CGNAT appliance configuration syntax and commands.

NAT Pool Configuration

A NAT IP address pool includes a set of public IPv4 addresses that are used for network address translation. You can create multiple public IPv4 address pools and one pool includes a range of public IPv4 addresses. These pools allocate public IPv4 addresses to subscribers during address translation. While configuring a pool, you can define the group of public IPv4 addresses belonging to that pool by specifying the lowest and highest IP addresses.

The system allows you to create multiple pools and define the association among them. You can define the 'next-pool-name' that takes over when the current pool gets exhausted with the IPv4 addresses. When one pool gets exhausted, the next pool takes over and starts serving the IP addresses to subscribers when the address translation occurs.



Static and dynamic IP pools cannot be configured simultaneously; they are mutually exclusive.

Syntax:

set forwarding-options address-translation pool <pool-name> <attribute> <value>

Attribute	Description
<pool-name>	Specify the name of the address pool.
ipv4-address	Specify both the highest and lowest IPv4 addresses in the range of IPv4 addresses for the pool.
ipv4-address high	Specify the highest IPv4 address in the address pool. You must specify the highest IP address in the range of IP addresses.
ipv4-address low	Specify the lowest IPv4 address in the address pool. You must specify the lowest IP address in the range of IP addresses.
next-pool-name	Specify the name of the next address pool that is to be used when the current address pool is allocated completely.

Example Configuration:

The following commands configure nataddr_pool1 as the NAT pool and nataddr_pool2 as the next pool.

It indicates NAT pool nataddr_pool1 contains a range of public IPv4 addresses from 100.100.100.1 to 100.100.100.5.

When the pool nataddr_pool1 has fully allocated its IPv4 addresses, the next pool named nataddr_pool2 will start allocating IPv4 addresses from its pool. The pool nataddr_pool2 includes a rage of IPv4 address from 100.100.101.1 to 100.100.101.150.

```
set forwarding-options address-translation pool nataddr_pool1
set forwarding-options address-translation pool nataddr_pool1 next-pool-name
nataddr_pool2
set forwarding-options address-translation pool nataddr_pool1 ipv4-address low
100.100.100.1
set forwarding-options address-translation pool nataddr_pool1 ipv4-address high
100.100.100.5
set forwarding-options address-translation pool nataddr_pool2 ipv4-address low
100.100.101.1
set forwarding-options address-translation pool nataddr_pool2 ipv4-address high
```

```
100.100.101.150
```

Example Configuration:

```
supervisor@rtbrick: cfg> show config forwarding-options address-translation pool
{
  "rtbrick-config:pool": [
    {
      "pool-name": "nataddr_pool1",
      "next-pool-name": "nataddr_pool2",
      "ipv4-address": {
        "low": "100.100.100.1",
        "high": "100.100.100.5"
      }
    },
    {
      "pool-name": "nataddr_pool2",
      "ipv4-address": {
        "low": "100.100.101.1",
        "high": "100.100.101.150"
      }
    }
  ]
}
```

Configuring NAT Profile

A NAT profile defines how the NAT device has to perform the IPv4 address translation. NAT profile allows you to define an instance, IPv4 address pools, maximum number of translations, and mapping a particular internal IPv4 address with a particular external IPv4 address for a deterministic address translation.

A single NAT profile can be attached to subscribers across different instances. This means that regardless of which instance a subscriber belongs to, they can share the same NAT profile. For example, subscribers in different routing instances can be managed using the same NAT settings.

Subscribers within the same instance can be assigned different NAT profiles. Different groups of subscribers or services within the same instance can have tailored NAT configurations.



The configuration limit of NAT rules per subscriber in NAT profile is 16,384.

Syntax:

set forwarding-options address-translation profile <profile-name> <attribute> <value>

Attribute	Description
<profile-name>	Specify the NAT profile name.
deterministic [true]	Specify deterministic as true to enable deterministic NAT for the profile. Deterministic NAT allows subscribers always to connect with a single public IP.
ip-protocol	Specify the protocol: tcp, udp, or other.
ip-protocol ageing-timeout <ageing-timeout>	Specify the ageing time value for the protocol. Default, 300 seconds for TCP and UDP. The allowed Ageing Time Out range values are as follows: • TCP: 60 - 86400 seconds • UDP: 120 - 86400 seconds
ip-protocol control-plane-ageing-timeout <ageing-timeout>	Specify the TCP/UDP control plane ageing timeout value. Allowed range: 5 - 120 seconds. * Default, 10 seconds for TCP traffic. * Default, 30 seconds for UDP traffic.
max-rules	Specify the maximum number of rules per subscriber or an interface. The supported values for maximum address translation for an interface are 64, 128, 256, 512, 1024, 2048, 4096, 8192, and 16384.
pool	Specify the name of the public IP address pool.

The following commands configure the NAT profile named nat_profile1. The nat profile nat_profile1 is configured on the instanced vrf1 with a pool attached nataddr_pool1. Maximum rules are configured as 128 rules and the aging period is configured as 600 seconds for TCP traffic, 300 seconds for UDP traffic, and 300 for 'other' traffic.

```
set forwarding-options address-translation profile nat_profile1
set forwarding-options address-translation profile nat_profile1 instance vrf1
set forwarding-options address-translation profile nat_profile1 pool nataddr_pool1
```

```
set forwarding-options address-translation profile nat_profile1 ip-protocol tcp
ageing-timeout 600
set forwarding-options address-translation profile nat_profile1 ip-protocol udp
ageing-timeout 300
set forwarding-options address-translation profile nat_profile1 ip-protocol other
ageing-timeout 300
```

Example Configuration:

```
supervisor@rtbrick.net: cfg> show config forwarding-options address-translation
profile
{
  "rtbrick-config:profile": [
    {
      "profile": "nat_profile1",
      "instance": "vrf1",
      "pool": "nataddr_pool1",
      "ip-protocol": {
        "tcp": {
          "ageing-timeout": 600
        },
        "udp": {
          "ageing-timeout": 300
        },
        "other": {
          "ageing-timeout": 300
        }
      }
    }
  ]
}
```

Enable NAT on an Instance

You can enable address translation for a specific routing instance such as VRF or virtual router rather than globally across the entire router.

Syntax:

set instance <instance-name> **address-translation true**

Attribute	Description
<instance-name>	Name of the instance.

The following command is used to enable address translation for the instance named 'vrf1'.

```
set instance vrf1 address-translation true
```

```
supervisor@rtbrick.net: op> show config instance vrf1 address-translation
{
  "rtbrick-config:address-translation": "true"
}
```

Attaching NAT Profile and Direction to L3 Logical Interface

Enabling NAT on a Private Network L3 Interface

To enable NAT on a private network L3 interface, you need to configure the direction of the network interface as the "local".

Syntax:

set interface <interface-name> **unit** <unit-id> **address-translation** <attribute> <value>

Attribute	Description
<interface-name>	Name of the interface. Example: ifp-0/0/1.
unit <unit-id>	Create a logical interface (also referred to as a sub-interface) under the physical interface.
profile <profile-name>	Specify the NAT profile name.
direction local	Indicates the NAT configuration on a private network.

The following command attaches the NAT profile nat_profile in the local direction to an L3 logical interface.

```
supervisor@rtbrick>multiservice-edge1.rtbrick.net: cfg> show config set interface
ifp-0/0/1
set interface ifp-0/0/1
set interface ifp-0/0/1 unit 100
set interface ifp-0/0/1 unit 100 address-translation
set interface ifp-0/0/1 unit 100 address-translation direction local
set interface ifp-0/0/1 unit 100 address-translation profile nat_profile
```

Example Configuration:

```
supervisor@rtbrick>multiservice-edge1.rtbrick.net: cfg> show config  interface
ifp-0/0/1
{
  "rtbrick-config:interface": [
    {
      "name": "ifp-0/0/1",
      "unit": [
        {
          "unit-id": 100,
          "address-translation": {
            "direction": "local",
            "profile": "nat_profile"
          }
        }
      ]
    }
  ]
}
```

Enabling NAT on a Public Network L3 Interface

To enable NAT on a public network L3 interface, you need to configure the direction of the network interface as the "public".

Syntax:

set interface <interface-name> **unit** <unit-id> **address-translation** <attribute> <value>

Attribute	Description
<interface-name>	Name of the interface.
<unit-id>	Configure the number of sub-interfaces under the physical interface.
direction public	Specify 'public' for the external interface.

The following commands configure the external interface ifp-0/1/64 for IPv4 address translation. 'Unit' logical identifier for this physical interface. Direction 'public' shows the configuration on external interface for address translation.

```
set interface ifp-0/1/64 unit 100
set interface ifp-0/1/64 unit 100 address-translation
set interface ifp-0/1/64 unit 100 address-translation direction public
```

```
supervisor@rtbrick.net: cfg> show config interface ifp-0/1/64 unit 100
{
  "rtbrick-config:unit": [
    {
      "unit-id": 100,
      "address-translation": {
        "direction": "public"
      }
    }
  ]
}
```

NAT Rule Configuration

You can define NAT rules only for static NAT. A NAT rule defines a match condition and a corresponding action. After you specify NAT rules, each packet is matched with each NAT rule. If a packet matches the condition specified in a rule, then the action corresponding to that match occurs. Match rules govern how the translation of private IPv4 addresses to public IPv4 addresses is performed.

With NAT rules, you can define how address translation is applied to traffic, and how to handle various protocols and data traffic, such as TCP and UDP, to ensure proper address translation and the mappings of private addresses to public addresses.

Rules also define how to handle inbound and outbound traffic, different protocols, and data traffic such as TCP and UDP for ensuring the proper address translation of traffic.



A maximum of 16,384 NAT rules on NAT profile is allowed.

Syntax:

set forwarding-options address-translation rule <rule-name> <attribute> <value>

Attribute	Description
<rule-name>	Specify the name of the rule.
ordinal <ordinal-value>	Specify the ordinal value. An ordinal value is a numerical representation that indicates its relative position or order.

Attribute	Description
ordinal <ordinal-value> instance	Specify the RBFS instance name.
ordinal <ordinal-value> ip-protocol [tcp/udp]	Specify the IP protocol, TCP or UDP.
ordinal <ordinal-value> local [ipv4-address/port]	Specify the private IPv4 address or port number that needs to be translated.
ordinal <ordinal-value> public [ipv4-address/port]	Specify the public IPv4 address. This public IP will be mapped with the private IP in the translation table.

Enable Logging for NAT

You can optionally enable logging for CGNAT appliance operations.



All RBFS logs and related information is available in the *RBFS Logging User Guide*. For the list of RBFS logs, see Log Reference.

set log bd <name> <options>

Attribute	Description
level	Specify the log level.
module	Specify the log module.
plugin-alias	Specify the plugin-alias URL. Plugin-alias is an external logging host server to which you can export logs. For example, Graylog.

The following commands configure logging for NAT module natd with a log level 'debug'.

```
set log bd natd
set log bd natd module nat
set log bd natd module nat level debug
```

```
supervisor@rtbrick.net: cfg> show config log bd natd
{
  "rtbrick-config:bd": [
    {
      "bd-name": "natd",
```

```
      "module": [
        {
          "module-name": "nat",
          "level": "debug"
        }
      ]
    }
  ]
}
```

Enabling NAT ACL Support for ICMP and TCP Control Messages

You can enable Access Control Lists support for ICMP and TCP Control messages.

Enabling NAT Support for ICMP Using ACLs

The NAT ACLs for ICMP packets allows address translation for ICMP request and response packets through the use of Access Control Lists (ACLs). This enhances the handling of ICMP traffic by providing precise control over NAT behavior for ICMP packets.



Setting up the NAT ACLs for ICMP will be handled by the NAT application with the 25.1.1 release, eliminating the need for manual configuration.

set forwarding-options acl l3v4 rule rule-name> ordinal <ordinal-number> <attribute > <value>

Attribute	Description
<rule-name>	Specify the name of the rule.
ordinal <ordinal-value>	Specify the ordinal value. An ordinal value is a numerical representation that indicates its relative position or order.
match	Define the conditions under which the rule will be applied. These conditions determine which packets the rule should act on.
action	Defines what happens to packets that match the rule's criteria.
priority	Determines the priority of the rule when multiple rules with the same ordinal value are evaluated.

Attribute	Description
direction	The rule applies to ingress or egress traffic.

Example commands:

```
set forwarding-options acl l3v4 rule NAT_TRAP
set forwarding-options acl l3v4 rule NAT_TRAP ordinal 1001
set forwarding-options acl l3v4 rule NAT_TRAP ordinal 1001 match direction ingress
set forwarding-options acl l3v4 rule NAT_TRAP ordinal 1001 match ip-protocol icmp
set forwarding-options acl l3v4 rule NAT_TRAP ordinal 1001 match destination-ipv4-
prefix-list PREFIXES_NAT_PUBLIC
set forwarding-options acl l3v4 rule NAT_TRAP ordinal 1001 action trap nat
set forwarding-options acl l3v4 rule NAT_TRAP ordinal 1001 priority 1001

set forwarding-options acl l3v4 rule NAT_TRAP ordinal 1002
set forwarding-options acl l3v4 rule NAT_TRAP ordinal 1002 match direction ingress
set forwarding-options acl l3v4 rule NAT_TRAP ordinal 1002 match source-ipv4-
prefix 100.64.0.0/10
set forwarding-options acl l3v4 rule NAT_TRAP ordinal 1002 match ip-protocol icmp
set forwarding-options acl l3v4 rule NAT_TRAP ordinal 1002 action trap nat
set forwarding-options acl l3v4 rule NAT_TRAP ordinal 1002 priority 1002
```

Example:

```
supervisor@rtbrick>rtbrick.net: cfg> show config forwarding-options acl l3v4
{
  "rtbrick-config:l3v4": {
    "rule": [
      {
        "rule-name": "NAT_TRAP",
        "ordinal": [
          {
            "ordinal-value": 1001,
            "match": {
              "direction": "ingress",
              "ip-protocol": "icmp",
              "destination-ipv4-prefix-list": "PREFIXES_NAT_PUBLIC"
            },
            "action": {
              "trap": "nat"
            },
            "priority": 1001
          },
          {
            "ordinal-value": 1002,
            "match": {
              "direction": "ingress",
              "source-ipv4-prefix": "100.64.0.0/10",
              "ip-protocol": "icmp"
            },
            "action": {
              "trap": "nat"
            },
            "priority": 1002
          }
```

```
        ]
      }
    ]
      }
    }
```

The preceding configuration defines Layer 3 IPv4 Access Control List (ACL) rules for managing ICMP traffic. The rule with the ordinal value 1001 is designed to redirect ICMP traffic for Network Address Translation (NAT) processing based on specific criteria. The ACL rule is named NAT_TRAP.

The matching criteria for this rule include the direction of traffic, which is set to ingress. This means the rule applies only to incoming traffic. The specified protocol is ICMP, indicating that the rule is applicable to ICMP packets.

The 'destination-ipv4-prefix-list' is designated as PREFIXES_NAT_PUBLIC, which is a predefined list containing a range of IPv4 addresses. The rule specifically pertains to ICMP packets whose destination IP is included in the PREFIXES_NAT_PUBLIC list. These rules ensure that ICMP packets requiring NAT handling are identified and appropriately redirected to the NAT process. When an ICMP packet that meets the conditions (ingress, ICMP, and a destination in PREFIXES_NAT_PUBLIC) is detected, it is redirected (or punted) to the NAT process for further handling.

Enabling NAT Support for TCP Control Messages Using ACL

This configuration enables address translation on TCP control messages through ACLs. The feature supports control messages such as FIN, SYN, and RST. It applies functionality to TCP control messages such as fin-ack and rst-ack.

Syntax:

set forwarding-options acl l3v4 rule <rune-name> **ordinal** <ordinal-number> **match tcp-control** [fin-ack | rst-ack]

Attribute	Description
<rule-name>	Specify the name of the rule.
ordinal <ordinal-value>	Specify the ordinal value. An ordinal value is a numerical representation that indicates its relative position or order.

Attribute	Description
match	Define the conditions under which the rule will be applied. These conditions determine which packets the rule should act on.
action	Defines what happens to packets that match the rule's criteria.
priority	Determines the priority of the rule when multiple rules with the same ordinal value are evaluated.
direction	The rule applies to ingress or egress traffic.
tcp-control <fin-ack>	Matches TCP packets with the FIN-ACK control flag set. When using the tcp-control match attribute in a match rule, it is necessary to explicitly configure match ip-protocol for TCP. This ensures that the rule accurately identifies and processes TCP packets before applying any matching for TCP control flags.
destination-ipv4-prefix-list	Name of the prefix list. The list includes predefined destination IP addresses.

Example commands:

```
set forwarding-options acl l3v4 rule NAT_TRAP ordinal 1003
set forwarding-options acl l3v4 rule NAT_TRAP ordinal 1003 match direction ingress
set forwarding-options acl l3v4 rule NAT_TRAP ordinal 1003 match tcp-control fin-
ack
set forwarding-options acl l3v4 rule NAT_TRAP ordinal 1003 match destination-ipv4-
prefix-list PREFIXES_NAT_PUBLIC
set forwarding-options acl l3v4 rule NAT_TRAP ordinal 1003 action trap nat
set forwarding-options acl l3v4 rule NAT_TRAP ordinal 1003 priority 1003
set forwarding-options acl l3v4 rule NAT_TRAP ordinal 1004
set forwarding-options acl l3v4 rule NAT_TRAP ordinal 1004 match direction ingress
set forwarding-options acl l3v4 rule NAT_TRAP ordinal 1004 match source-ipv4-
prefix 100.64.0.0/10
set forwarding-options acl l3v4 rule NAT_TRAP ordinal 1004 match tcp-control fin-
ack
set forwarding-options acl l3v4 rule NAT_TRAP ordinal 1004 action trap nat
set forwarding-options acl l3v4 rule NAT_TRAP ordinal 1004 priority 1004
set forwarding-options acl l3v4 rule NAT_TRAP ordinal 1005
set forwarding-options acl l3v4 rule NAT_TRAP ordinal 1005 match direction ingress
set forwarding-options acl l3v4 rule NAT_TRAP ordinal 1005 match tcp-control rst-
ack
set forwarding-options acl l3v4 rule NAT_TRAP ordinal 1005 match destination-ipv4-
prefix-list PREFIXES_NAT_PUBLIC
set forwarding-options acl l3v4 rule NAT_TRAP ordinal 1005 action trap nat
set forwarding-options acl l3v4 rule NAT_TRAP ordinal 1005 priority 1005
set forwarding-options acl l3v4 rule NAT_TRAP ordinal 1006
set forwarding-options acl l3v4 rule NAT_TRAP ordinal 1006 match direction ingress
```

```
set forwarding-options acl l3v4 rule NAT_TRAP ordinal 1006 match source-ipv4-
prefix 100.64.0.0/10
set forwarding-options acl l3v4 rule NAT_TRAP ordinal 1006 match tcp-control rst-
ack
set forwarding-options acl l3v4 rule NAT_TRAP ordinal 1006 action trap nat
set forwarding-options acl l3v4 rule NAT_TRAP ordinal 1006 priority 1006
```

Example:

```
supervisor@rtbrick>rtbrick.net: cfg> show config forwarding-options acl l3v4
{
  "rtbrick-config:l3v4": {
    "rule": [
      {
        "rule-name": "NAT_TRAP",
        "ordinal": [
          {
            "ordinal-value": 1003,
            "match": {
              "direction": "ingress",
              "tcp-control": "fin-ack",
              "destination-ipv4-prefix-list": "PREFIXES_NAT_PUBLIC"
            },
            "action": {
              "trap": "nat"
            },
            "priority": 1003
          },
          {
            "ordinal-value": 1004,
            "match": {
              "direction": "ingress",
              "source-ipv4-prefix": "100.64.0.0/10",
              "tcp-control": "fin-ack"
            },
            "action": {
              "trap": "nat"
            },
            "priority": 1004
          },
          {
            "ordinal-value": 1005,
            "match": {
              "direction": "ingress",
              "tcp-control": "rst-ack",
              "destination-ipv4-prefix-list": "PREFIXES_NAT_PUBLIC"
            },
            "action": {
              "trap": "nat"
            },
            "priority": 1005
          },
          {
            "ordinal-value": 1006,
            "match": {
              "direction": "ingress",
              "source-ipv4-prefix": "100.64.0.0/10",
              "tcp-control": "rst-ack"
            },
```

```
            "action": {
              "trap": "nat"
            },
            "priority": 1006
          }
        ]
      }
    ]
  }
}
```

The preceding configuration defines ACL for Layer 3 IPv4 traffic. The ACL is named NAT_TRAP and consists of multiple rules that match specific traffic patterns and apply a 'trap' action to punt the traffic for further NAT processing. Each rule is identified by an ordinal value.

Match Criteria includes direction which is specified as ingress. All rules are applied to ingress traffic. Protocol is defined as TCP traffic with specific control flags: fin-ack or rst-ack.

In the configuration:

- Ordinal 1003 matches TCP traffic with the fin-ack flag and a destination IP in the PREFIXES_NAT_PUBLIC list.
- Ordinal 1004 matches TCP traffic with the fin-ack flag and a source IP in the 100.64.0.0/10 range.
- Ordinal 1005 matches TCP traffic with the rst-ack flag and a destination IP in the PREFIXES_NAT_PUBLIC list.
- Ordinal 1006 matches TCP traffic with the rst-ack flag and a source IP in the 100.64.0.0/10 range.

Modifying the Policer on NAT Trap

You can modify a 'policer' associated with NAT traps, which directs certain packets to the control plane (hostpath). A NAT trap indicates when a device is performing network address translation, some packets that require special handling, are diverted to the control plane for processing.

To change the policer for NAT traps, use the following command:

Syntax:

set forwarding-options address-translation trap policer <policer-name>

Attribute	Description
<policer-name>	Specify the name of the policer.

Example for modifying the policer for NAT trap.

```
set forwarding-options address-translation trap policer _DEFAULT_POLICER_5_MB
```

Selective NAT Bypass Using Destination Prefix

RBFS CGNAT allows selective bypass of Network Address Translation based on destination IPv4 prefixes using an L3 ACL rule. Traffic matching the configured prefix in the specified direction is excluded from address translation. This feature enables you to preserve original source and destination addresses for specific networks.

Syntax

set forwarding-options acl l3v4 rule <name> **ordinal** <value> **match destination-ipv4-prefix** <prefix> **set forwarding-options acl l3v4 rule** <name> **ordinal** <value> **match direction ingress set forwarding-options acl l3v4 rule** <name> **ordinal** <value> **action trap default set forwarding-options acl l3v4 rule** <name> **ordinal** <value> **priority** <value>

The following configuration defines a rule named 'exclude_nat' with an ingress match condition. The rule matches traffic destined to the 10.10.10.1/24 prefix and assigns it a priority of 500 for processing order. Matching packets are trapped to the default control-plane handler, allowing the system to process them separately for excluding them from NAT handling.

```
set forwarding-options acl l3v4 rule exclude_nat
set forwarding-options acl l3v4 rule exclude_nat ordinal 1
set forwarding-options acl l3v4 rule exclude_nat ordinal 1 match destination-ipv4-
prefix 10.10.10.1/24
set forwarding-options acl l3v4 rule exclude_nat ordinal 1 match direction ingress
set forwarding-options acl l3v4 rule exclude_nat ordinal 1 action trap default
set forwarding-options acl l3v4 rule exclude_nat ordinal 1 priority 500
```

```
{
  "rtbrick-config:acl": {
    "l3v4": {
      "rule": [
        {
          "rule-name": "exclude_nat",
          "ordinal": [
            {
              "ordinal-value": 1,
              "match": {
                "destination-ipv4-prefix": "10.10.10.1/24",
                "direction": "ingress"
              },
              "action": {
                "trap": "default"
              },
              "priority": 500
            }
          ]
        }
      ]
    }
  }
}
```

5.4.3. CGNAT Appliance Operational Commands

CGNAT Appliance Show Commands

The CGNAT operational commands provide detailed information about the address translation operations.

NAT Pool Information

This command displays information about IPv4 address pool for a user.

Syntax:

show address-translation allocation <options>

Option	Description
pool	Specify the pool name.
user	Specify the user name.

Example for NAT pool allocation.

```
supervisor@rtbrick.net: cfg> show address-translation allocation pool
Pool: pool1
  Profile: nat_profile1
  Instance: vrf1
  Allocated: 100.00%
Pool: pool2
  Profile: nat_profile1
  Instance: vrf1
  Allocated: 100.00%
```

NAT Rule Details

Syntax:

show address-translation rule <options>

Option	Description
-	Without any option, the command displays the information for all rules.
instance	Displays NAT rule information for the specified instance.
summary	Displays summary of the information for the NAT rule.
user	Displays user information for the NAT rule.

Example for address translation rules for subscribers.

```
supervisor@rtbrick: cfg> show address-translation rule
Instance: vrf1
User                            Protocol   Original Address        Translated
Address      Direction
ifl-0/1/6/100                   tcp        11.100.129.0, 60011     100.200.200.6,
2825     Both
ifl-0/1/6/100                   tcp        11.100.130.0, 60011     100.200.200.9,
2027     Both
ifl-0/1/6/100                   tcp        11.100.128.1, 60011
100.200.200.39, 3283    Both
ifl-0/1/6/100                   tcp        11.100.129.1, 60011     100.200.200.4,
2828     Both
ifl-0/1/6/100                   tcp        11.100.131.1, 60011
100.200.200.32, 1260    Both
ifl-0/1/6/100                   tcp        11.100.129.3, 60011
100.200.200.46, 2796    Both
ifl-0/1/6/100                   tcp        11.100.128.4, 60011
100.200.200.30, 3328    Both
ifl-0/1/6/100                   tcp        11.100.130.4, 60011     100.200.200.3,
1945     Both
ifl-0/1/6/100                   tcp        11.100.129.5, 60011
100.200.200.39, 2796    Both
ifl-0/1/6/100                   tcp        11.100.130.5, 60011
```

```
100.200.200.45, 1934    Both
ifl-0/1/6/100                   tcp        11.100.128.6, 60011
100.200.200.25, 3304    Both
ifl-0/1/6/100                   tcp        11.100.129.7, 60011
100.200.200.36, 2650    Both
ifl-0/1/6/100                   tcp        11.100.130.7, 60011
100.200.200.31, 1982    Both
ifl-0/1/6/100                   tcp        11.100.128.8, 60011
100.200.200.18, 3294    Both
ifl-0/1/6/100                   tcp        11.100.130.8, 60011     100.200.200.5,
3651     Both
ifl-0/1/6/100                   udp        11.100.129.0, 60011     100.200.200.6,
2825     Both
ifl-0/1/6/100                   udp        11.100.130.0, 60011     100.200.200.9,
2027     Both
ifl-0/1/6/100                   udp        11.100.128.1, 60011
100.200.200.39, 3283    Both
ifl-0/1/6/100                   udp        11.100.129.1, 60011     100.200.200.4,
2828     Both
ifl-0/1/6/100                   udp        11.100.131.1, 60011
100.200.200.32, 1260    Both
ifl-0/1/6/100                   udp        11.100.129.3, 60011
100.200.200.46, 2796    Both
ifl-0/1/6/100                   udp        11.100.128.4, 60011
100.200.200.30, 3328    Both
ifl-0/1/6/100                   udp        11.100.130.4, 60011     100.200.200.3,
1945     Both
ifl-0/1/6/100                   udp        11.100.129.5, 60011
100.200.200.39, 2796    Both
ifl-0/1/6/100                   udp        11.100.130.5, 60011
100.200.200.45, 1934    Both
ifl-0/1/6/100                   udp        11.100.128.6, 60011
100.200.200.25, 3304    Both
ifl-0/1/6/100                   udp        11.100.129.7, 60011
100.200.200.36, 2650    Both
ifl-0/1/6/100                   udp        11.100.130.7, 60011
100.200.200.31, 1982    Both
ifl-0/1/6/100                   udp        11.100.128.8, 60011
100.200.200.18, 3294    Both
ifl-0/1/6/100                   udp        11.100.130.8, 60011     100.200.200.5,
3651     Both
<...>
```

The example summary shows the total number of NAT rules for other protocol flows:

```
supervisor@rtbrick.net: cfg> show address-translation rule
Instance: vrf1
User                            Protocol   Original Address        Translated
Address      Direction
ifl-0/1/6/100                   icmp       10.100.128.1, 7684
100.100.100.100, 1024   Both
```

NAT Trap Statistics

Syntax:

show address-translation trap statistics

This command displays the information of packets trapped in the NAT daemon.

Example for TCP flow stats

```
supervisor@rtbrick: cfg> show address-translation trap statistics
Protocol   Flags                     Status             Count
tcp        -|syn|-|-|-|-|-|-|-       Success           152958
tcp        -|syn|-|-|-|-|-|-|-       Failure            23186
Total Successful Traps:                                152958
Total Failed Traps:                                     23186
```

Example for TCP, UDP, ICMP(other) flow stats

```
supervisor@rtbrick: cfg> show address-translation trap statistics
Protocol   Flags                     Status             Count
tcp        -|syn|-|-|-|-|-|-|-       Success               60
tcp        fin|-|-|-|ack|-|-|-|-     Success                4
tcp        -|syn|-|-|ack|-|-|-|-     Failure               12
udp        -|-|-|-|-|-|-|-|-         Success              182
udp        -|-|-|-|-|-|-|-|-         Failure              326
other      -|-|-|-|-|-|-|-|-         Success             5292
Total Successful Traps:                                   5538
Total Failed Traps:                                        338
```

NAT Error Details

This command displays NAT error information.

Syntax:

show address-translation error

Example for address translation error:

```
supervisor@rtbrick.net: cfg> show address-translation error
INSTANCE - Packet Table
    Counter        : 4
    Current Update : Thu May 02 10:05:52 GMT +0000 2024
```

```
    Last Update    : Thu May 02 10:05:52 GMT +0000 2024
POOL_CFG - Pool Flush
    Counter        : 1
    Current Update : Thu May 02 10:05:43 GMT +0000 2024
    Last Update    : Thu May 02 10:05:43 GMT +0000 2024
```

Clear NAT Errors

Syntax:

clear address-translation error

This command resets the existing statistics for NAT errors.

5.5. RBFS HTTP Redirect Service

5.5.1. RBFS HTTP Redirect Service Overview

This document provides information about RBFS HTTP Redirect Service. For enabling HTTP Redirect service, it is required to create, associate, and apply subscriber filters (ACLs) for the subscribers. For information about subscriber filters and how to configure these filters, refer to the RBFS Subscriber Filters User Guide.

RBFS HTTP Redirect supports both IPoE and PPPoE subscribers.

RBFS HTTP Redirect service allows network service providers to intercept and redirect HTTP request traffic from subscribers to a designated captive portal instead of the original destination. This service is useful in a multitude of use cases, ranging from subscriber re-authentication to enforcing acceptance of network usage policies.

This captive portal is a webpage where the redirected subscribers are landed up to fulfill certain actions or conditions before they are granted broader access to the network resources. There are various reasons why captive portals can be set up, such as the following:

- Accept the terms of service.
- Receive and manage HTTP requests to unauthorized web resources.

- Present a web page that requires the completion of certain actions from the subscriber.
- Serve commercial communication or network usage policy messages.

By implementing the RBFS HTTP Redirect Service, network service providers can efficiently manage user access and enforce compliance with network regulations and policies, ultimately enhancing the overall security and user experience within their network environment.

Based on the applied filters, RBFS performs three actions which are accept, drop, and redirect. The action Accept allows the subscribers to access the network resource that they request. The Drop action restricts the subscriber from accessing the network resource. Finally, the Redirect action, if enabled HTTP redirect service, takes the subscriber to a different portal where the service provider wants to fulfill certain actions by the subscriber before accessing the network resource.

In addition to RBFS Subscriber Filters, a redirect action is supported by RBFS through the utilization of Ascend Data Filters (ADF), as described in the RBFS RADIUS Services Guide.

The RBFS HTTP Redirect Service together with the Subscriber Filters empowers network service providers to intercept and redirect HTTP request traffic from subscribers, guiding it towards a designated captive portal instead of its original destination.

How RBFS HTTP Redirect Service Works

HTTP requests from subscribers to any destination are intercepted by the RBFS HTTP Redirect service, if the subscriber filter rules are applied to the subscriber. In response to the request from the subscriber to access the network, the HTTP Redirect service provides the HTTP status code 302 along with the new URL to guide the subscriber to the new destination. To make it possible, the RBFS Subscriber Filters are employed, enabling the service to decide which requests should be redirected and which requests should be passed directly without redirection. In addition to RBFS Subscriber Filters, a redirect action is supported by RBFS through the utilization of Ascend Data Filters (ADF), as described in the RBFS RADIUS Services Guide.

Enabling HTTP Redirect Service Using RADIUS ADF

Both the RBFS Subscriber Filters and the HTTP Redirect Service can be dynamically enabled, disabled, and updated through RADIUS access-accept and CoA requests without requiring the re-establishment of the subscriber session. This flexibility allows network administrators to efficiently manage and modify these services as needed without disrupting subscriber connectivity.

RBFS provides a set of vendor-specific attributes to control the RBFS Subscriber Filters and the HTTP Redirect Service. The attributes include:

- VSA 26-50058-75 - RtBrick-HTTP-Redirect-URL
- VSA 26-50058-76 - RtBrick-IPv4-ACL-IN
- VSA 26-50058-77 - RtBrick-IPv4-ACL-OUT
- VSA 26-50058-78 - RtBrick-IPv6-ACL-IN
- VSA 26-50058-79 - RtBrick-IPv6-ACL-OUT

For more information about these attributes, see RBFS RADIUS Services Guide.

Limitations

The HTTP Redirect Service is supported for IPoE and PPPoE subscribers. HTTP Redirect service can redirect only HTTP traffic. Typically, the majority of web requests are in HTTPS format, which cannot be redirected. Due to this limitation, most end-user devices, including PCs, smartphones, and tablets, automatically attempt to access specific well-known URLs to search for captive portals immediately after establishing a network connection. Two common examples are http://connectivitycheck.gstatic.com (vendor-independent) and http://captive.apple.com (Apple devices).

5.5.2. HTTP Redirect Service Configuration

The configuration hierarchy for the HTTP Redirect service is illustrated in the diagram.

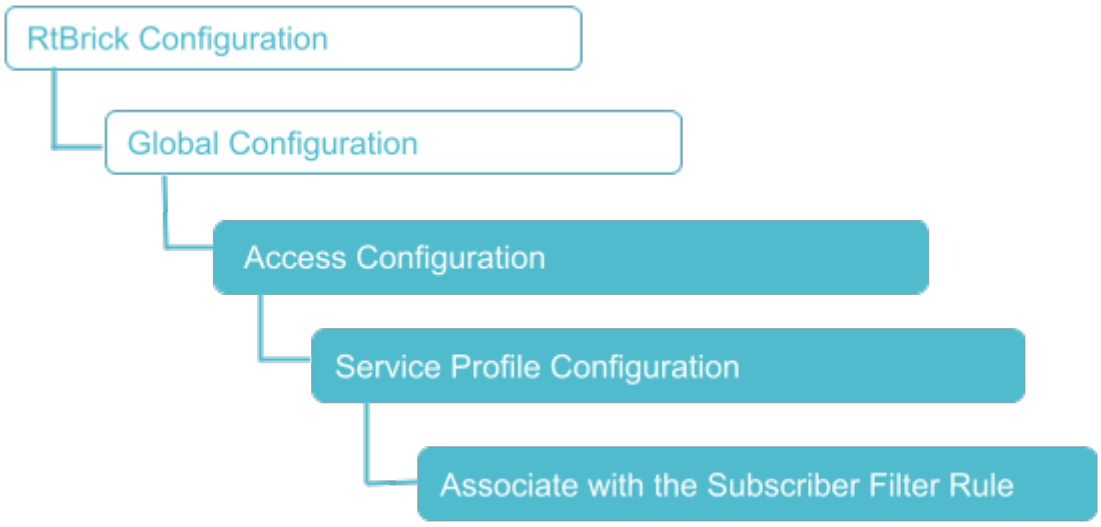


Figure 89. HTTP Redirect Configuration Hierarchy

Service Profile Configuration

Syntax:

set access service-profile profile-name <profile-name> <attribute> <value>

Attribute	Description
<profile-name>	Service profile name.
<http-redirect>	HTTP redirect service configuration.
<url>	HTTP redirect target URL.
<acl>	Subscriber ACL (filter) configuration.
<ipv4-acl-in>	IPv4 upstream ACL (ingress from subscriber).
<ipv4-acl-out>	IPv4 downstream ACL (egress to subscriber).
<ipv6-acl-in>	IPv6 upstream ACL (ingress from subscriber).
<ipv6-acl-out>	IPv6 downstream ACL (egress to subscriber).

Example:

The following configuration specifies the HTTP redirect URL as: https://www.rtbrick.com. It associates the subscriber ACL with the profile. The ACL named 'redirect-acl-in' will determine which traffic is matched and redirected.

```
set access service-profile HTTP
set access service-profile HTTP http-redirect url https://www.rtbrick.com
set access service-profile HTTP acl ipv4-acl-in redirect-acl-in
```

The following example shows the HTTP redirect URL for the service profile.

```
supervisor@router: cfg> show config access service-profile HTTP
{
  "rtbrick-config:service-profile": [
    {
      "profile-name": "HTTP",
      "http-redirect": {
        "url": "https://www.rtbrick.com"
      },
      "acl": {
        "ipv4-acl-in": "redirect-acl-in"
      }
    }
  ]
}
```

5.5.3. HTTP Redirect Operational Commands

HTTP Redirect Show Commands

The show commands provide detailed information about the HTTP Redirect services.

HTTP Redirect Information

You can use the operational commands for monitoring and managing HTTP redirect services. These commands enable you to view configured HTTP redirect services, display operational statistics, and clear collected statistics.

Syntax:

show http-redirect <option>

Attribute	Description
statistics	Displays operational statistics for HTTP redirect services for monitoring.

Attribute	Description
services	Displays the configured HTTP redirect services on the device.

Example:

```
show http-redirect services
show http-redirect statistics
```

Example output for HTTP redirect statistics.

```
supervisor@rtbrick.net: cfg> show http-redirect statistics
HTTP Response Sent:
302 Redirect    : 4
404 Not-Found   : 0

Errors:
IFL Missing     : 0
Context Missing : 0
Duplicate TCP   : 0

TCP Events:
Accepted        : 4
Received        : 4
Sent            : 4
Pollout         : 0
Error           : 0
Close           : 4
Closed          : 0
```

Clear Commands

The clear http-redirect statistics is used to reset the HTTP redirect statistics counters.

Syntax

clear oam bfd session <option>

Example command:

```
clear http-redirect statistics
```

5.6. RBFS Subscriber Filters

5.6.1. RBFS Subscriber Filters Overview

RBFS Subscriber Filters, also referred to as subscriber ACLs, consist of a set of rules defining packet match criteria and actions. There are separate rules for IPv4 and IPv6 downstream (egress to subscriber) and upstream (ingress from subscriber) packets. These rules support various match criteria and actions, some of which are specific to address families or directions. Each rule is assigned a priority, and the decision between multiple matching rules is based on these priorities, where lower values take precedence.

The available actions include accept, drop, or http-redirect where the last one refers to the RBFS HTTP Redirect Service. When the action is drop, matching traffic is silently discarded. The filters are categorized into two primary types, namely l3v4 for IPv4 and l3v6 for IPv6, applicable to either ingress or egress direction.

To apply these filters to subscribers, there are two ways. They can be applied through the access service-profile or directly using the corresponding RADIUS attributes with the second method taking priority.

About the Match Criteria

When multiple match criteria are defined within a single rule, they are treated as a logical AND operation, requiring all criteria to be met for the rule to be considered as a match. However, using unsupported match criteria, such as destination-ipv4-subscriber-prefix in ingress (upstream), can potentially lead to session termination. In the case of CoA (Change of Authorization), the filter assignment is rejected using CoA NAK, if such unsupported criteria are encountered.

Even if filters are assigned to a subscriber, those filters are applied globally, indicating that all traffic from all interfaces and subscribers is evaluated against all rules. Consequently, RBFS has introduced specific options to restrict rules to individual subscribers. For ingress (upstream) rules, it is recommended to enable the subscriber-ifl option, ensuring that only traffic received from the corresponding subscriber is matched. With the subscriber-ifl option, packets are matched based on incoming subscriber IFL. However, this option is not supported in egress(downstream), requiring the limitation of traffic using subscriber address prefix information. Thus, RBFS introduced the options source-ipv4-subscriber-prefix, source-ipv6-subscriber-prefix, destination-ipv4-subscriber-prefix,

destination-ipv6-subscriber-prefix, source-ipv6-delegated-subscriber-prefix, and destination-ipv6-delegated-subscriber-prefix. With these options enabled, the dynamically assigned subscriber address prefix is automatically integrated into the corresponding filter instance to constrain those rules to a specific subscriber.



Improperly configured filters assigned to one subscriber may create a negative impact on other subscribers as well.

5.6.2. Subscriber Filters Configuration

The configuration hierarchy for Subscriber ACL is illustrated in the diagram.

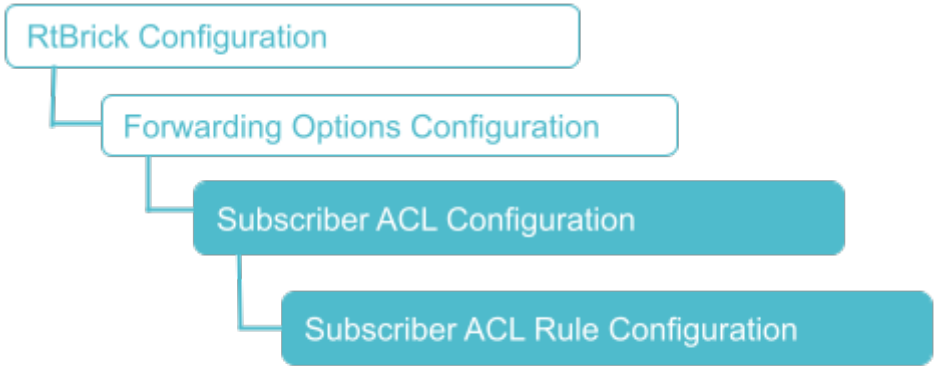


Figure 90. Subscriber Filters Configuration Hierarchy

Configure Subscriber Filters

Syntax:

set forwarding-options subscriber-acl <l3v4|l3v6> **rule** <rule-name> **ordinal** <ordinal-value> <option> <attribute> <value>

Attribute	Description
<l3v4 | l3v6>	Specify l3v4 for IPv4 and l3v6 for IPv6.
<rule-name>	Subscriber ACL rule name.
<ordinal-value>	The mandatory ordinal value is used to differentiate multiple rules within the rule set.

Attribute	Description
action	The desired action, which can be either permit, drop or http-redirect.
priority <priority-value>	The priority of the rule, where the lower value has a higher priority.
match	The match criteria.

Configuring Subscriber Filter Match Criteria

Syntax:

set forwarding-options subscriber-acl <l3v4|l3v6> **rule** <rule-name> **ordinal** <ordinal-value> **match** <attribute> <value>

Attribute	Description
destination-ipv4-prefix <destination-ipv4-prefix>	Packets are matched when the IPv4 destination address is within the defined prefix.
destination-ipv4-prefix-list <destination-ipv4-prefix-list>	Packets are matched when the IPv4 destination address is within one of the prefixes listed in the defined prefix list.
destination-ipv4-subscriber-prefix true	Packets are matched when the IPv4 destination address is within the dynamically assigned subscriber IPv4 address prefix (sometimes, referred to framed prefix). Consequently, this option shares similarity to the destination-ipv4-prefix, where the prefix is automatically set to the dynamic subscriber prefix. This option is allowed only in the egress (downstream) direction.
destination-ipv6-prefix <destination-ipv6-prefix>	Packets are matched when the IPv6 destination address is within the defined prefix.
destination-ipv6-prefix-list <destination-ipv6-prefix-list>	Packets are matched when the IPv6 destination address is within one of the prefixes listed in the defined prefix list.

Attribute	Description
destination-ipv6-subscriber-prefix true	Packets are matched when the IPv6 destination address is within the dynamically assigned subscriber IPv6 address prefix (sometimes, referred to framed prefix). Consequently, this option shares similarity to the destination-ipv4-prefix, where the prefix is automatically set to the dynamic subscriber prefix. This option is allowed only in the egress (downstream) direction.
destination-ipv6-delegated-subscriber-prefix <destination-ipv6-delegated-subscriber-prefix>	This option is similar to the destination-ipv6-subscriber-prefix using the dynamically delegated prefix instead.
source-ipv4-prefix <source-ipv4-prefix>	Packets are matched when the IPv4 source address is within the defined prefix.
source-ipv4-prefix-list <source-ipv4-prefix-list>	Packets are matched when the IPv4 source address is within one of the prefixes listed in the defined prefix list.
source-ipv4-subscriber-prefix <source-ipv4-subscriber-prefix>	Packets are matched when the IPv4 source address is within the dynamically assigned subscriber IPv4 address prefix (sometimes, referred to framed prefix). Consequently, this option shares similarity to source-ipv4-prefix, where the prefix is automatically set to the dynamic subscriber prefix. This option is allowed only in the ingress (upstream) direction.
source-ipv6-prefix <source-ipv6-prefix>	Packets are matched when the IPv6 source address is within the defined prefix.
source-ipv6-prefix-list <source-ipv6-prefix-list>	Packets are matched when the IPv6 source address is within one of the prefixes listed in the defined prefix list.

Attribute	Description
source-ipv6-subscriber-prefix <source-ipv6-subscriber-prefix>	Packets are matched when the IPv6 source address is within the dynamically assigned subscriber IPv6 address prefix (sometimes, referred to framed prefix). Consequently, this option shares similarity to source-ipv4-prefix, where the prefix is automatically set to the dynamic subscriber prefix. This option is allowed only in the ingress (upstream) direction only.
source-ipv6-delegated-subscriber-prefix true	This option is similar to the source-ipv6-subscriber-prefix using the dynamically delegated prefix instead. To disable this configuration, use the delete form of the command.
source-l4-port <source-l4-port>	Packets are matched based on the layer 4 source port (TCP or UDP port).
destination-l4-port <destination-l4-port>	Packets are matched based on the layer 4 destination port (TCP or UDP port).
ip-protocol <ip-protocol>	Packets are matched depending on the IP protocol (TCP or UDP). However, this option is not compatible with the MPLS-encapsulated traffic. Consequently, filtering based on IP protocol is not possible for MPLS traffic received from the core. For instance, it is feasible to drop all traffic to port 80, but it is not possible to selectively drop only TCP traffic while permitting UDP traffic when receiving traffic with an MPLS label.
subscriber-ifl true	Packets are matched based on incoming subscriber IFL. This option is allowed only in the ingress (upstream) direction.

Configuring Subscriber Filter Actions

Syntax:

set forwarding-options subscriber-acl <l3v4|l3v6> **rule** <rule-name> **ordinal** <ordinal-value> **action** <attribute> <value>

Attribute	Description
permit	Forward packets.
drop	Silently discard packets.
http-redirect true	Specify true to enable the redirect service. To disable http-redirect, use the delete form of the command.

Example:

The following configuration sets an ACL for subscriber traffic that targets TCP traffic directed to port 80 (HTTP). The rule is named ipv4-acl-in. The IP protocol used is TCP, and the transport port is set to 80 (indicating HTTP traffic). When the specified conditions are met, the action is to redirect traffic to a captive portal. The configuration also sets the priority of the rule. The rule is assigned a specific priority value, that is 1001. Higher numeric value takes a lower priority.

```
set forwarding-options subscriber-acl l3v4 rule ipv4-acl-in
set forwarding-options subscriber-acl l3v4 rule ipv4-acl-in ordinal 1
set forwarding-options subscriber-acl l3v4 rule ipv4-acl-in ordinal 1 match
destination-l4-port 80
set forwarding-options subscriber-acl l3v4 rule ipv4-acl-in ordinal 1 match ip-
protocol tcp
set forwarding-options subscriber-acl l3v4 rule ipv4-acl-in ordinal 1 action http-
redirect true
set forwarding-options subscriber-acl l3v4 rule ipv4-acl-in ordinal 1 priority
1001
supervisor@M3-STD-44-4403>bm15-tst.fsn.rtbrick.net: cfg> show config  forwarding-
options subscriber-acl
```

```
{
  "rtbrick-config:subscriber-acl": {
    "l3v4": {
      "rule": [
        {
          "rule-name": "ipv4-acl-in",
          "ordinal": [
            {
              "ordinal-value": 1,
              "match": {
                "destination-l4-port": 80,
                "ip-protocol": "tcp"
              },
              "action": {
                "http-redirect": "true"
              },
              "priority": 1001
            }
          ]
        }
      ]
```

```
    }
  }
}
```

Attaching the ACL Rule with the Service Profile

Syntax:

set access service-profile profile-name <profile-name> <attribute> <value>

Attribute	Description
<profile-name>	Service profile name.
<http-redirect>	HTTP redirect service configuration.
<url>	HTTP redirect target URL.
<acl>	Subscriber ACL (filter) configuration.
<ipv4-acl-in>	IPv4 upstream ACL (ingress from subscriber).
<ipv4-acl-out>	IPv4 downstream ACL (egress to subscriber).
<ipv6-acl-in>	IPv6 upstream ACL (ingress from subscriber).
<ipv6-acl-out>	IPv6 downstream ACL (egress to subscriber).

5.6.3. Subscriber Filters Operational Commands

Subscriber Filters Show Commands

The show commands provide detailed information about the subscriber filter.

Subscriber ACL (Filter) Information

The show subscriber <id> acl command provides a comprehensive list of all ACL instances initiated for the subscriber, including RBFS Subscriber Filters and Ascend Data Filters (ADF). Additionally, this command provides the option to view detailed information for each filter instance by appending the corresponding filter name. Consequently, the filters are displayed with all variables, such as destination-ipv4-subscriber-prefix, replaced by their actual prefixes for clarity.

Syntax:

show subscriber <subscriber-id> **acl** <acl_name> **type** (**l3v4** | **l3v6**)

Attribute	Description
<subscriber-id>	Identifier of the subscriber for which to display ACL information.
<acl_name>	Name of the ACL associated with the subscriber.
type (l3v4|l3v6)	Type of the ACL, either IPv4 (l3v4) or IPv6 (l3v6).

Example 1: ACL summary information for a specific subscriber

```
supervisor@rtbrick: op> show subscriber 216454257090494476 acl
Rule                                                Ordinal    Priority     Type
subscriber-filter-ipoe-0/1/49/216454257090494476    0          1
subscriber_framed_ipv4_filters
                                                    1          2
subscriber_framed_ipv6_filters
                                                    1          2
subscriber_delegated_ipv6_filters
```

Example 2: Summary information for a specific subscriber ACL

```
supervisor@rtbrick: op> show subscriber 1369375761697341441 acl ipv4-acl-in-ipoe-
lag-1/1369375761697341441
Rule: ipv4-acl-in-ipoe-lag-1/1369375761697341441
  ACL type: l3v4
  Ordinal: 1
  Priority: 1001
    Match:
      Direction: ingress
      Destination L4 port: 80
      IP protocol: TCP
    Action:
      HTTP-redirect: True       URL: www.rtbrick.com
```

Example 3: Display the ACL information for a subscriber with the ID '123454257090494465' for acl 'subscriber_acl_1-ipoe-0/1/2/123454257090494465' of type 'l3v4'.

```
supervisor@rtbrick.net: op> show subscriber 123454257090494465 acl
subscriber_acl_1-ipoe-0/1/2/123454257090494465 type l3v4
Rule: subscriber_acl_1-ipoe-0/1/2/123454257090494465
  ACL type: l3v4
  Ordinal: 0            Priority: 1001
```

```
    Match:
      Direction: ingress
      Destination IPv4 address: 192.0.2.6
      Source IPv4 prefix: 203.0.113.3/32

    Action:
      Permit: True
```

5.7. Lawful Interception

5.7.1. Lawful Interception Overview

Lawful Interception (LI) is a legal requirement mandated by national regulations in many regions. It enables authorized Law Enforcement Agencies (LEA) to access specific communication data from Communication Service Providers (CSP).

In RBFS, Lawful Interception enables the selective capture of subscriber sessions in both directions (upstream and downstream). The intercepted traffic is tunneled to a Mediation Device (MD), along with metadata indicating the direction of capture and a reference to the intercepted connection or session.

RBFS supports LI in accordance with applicable technical standards and regulatory requirements. The system enables dynamic rule provisioning and role-based access control, ensuring that only authorized personnel can configure or view LI-related information. All interception activities can be logged for auditing and compliance purposes.

Components of Lawful Interception

The figure below shows the different components of the LI solution.

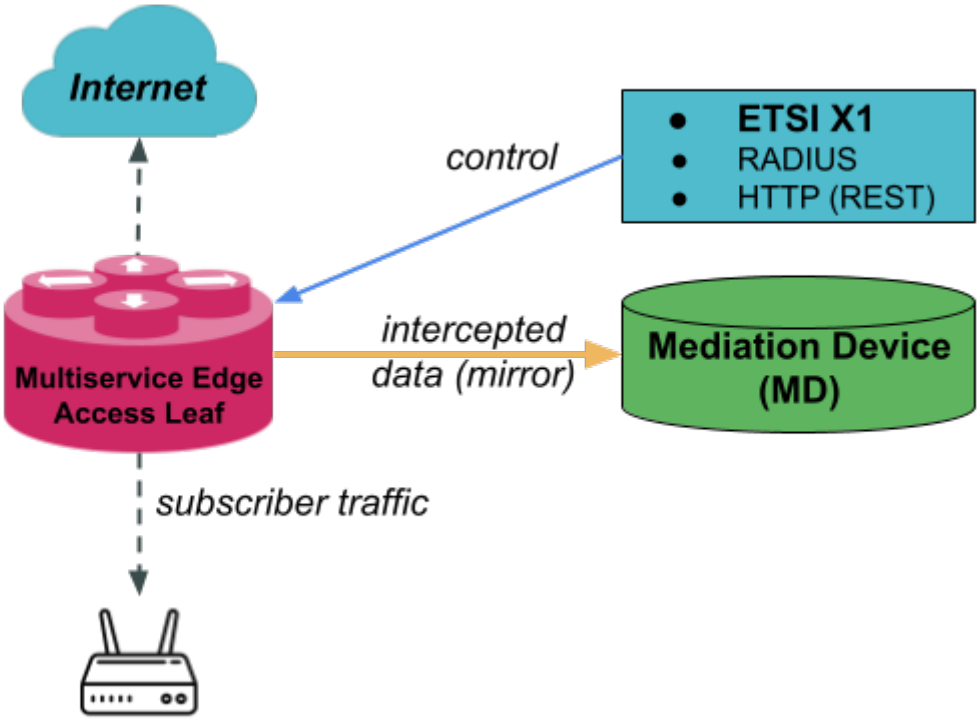


Figure 91. Components of Lawful Interception

RBFS supports multiple integration methods to implement Lawful Interception (LI), providing flexibility to match the operator's legal and technical requirements. The following three interfaces are supported for provisioning and managing interception sessions:

1. ETSI X1 Interface (see ETSI TS 101 671)
2. RADIUS Access-Accept and CoA using encrypted attributes
3. HTTP (REST) API

All three methods allow RBFS to set up interception sessions with precise control over subscriber identification, traffic direction, and metadata enrichment. Intercepted traffic is then tunneled to a Mediation Device (MD) using protocols compliant with national regulatory requirements. Role-based access control and full logging ensure that all LI-related actions are secure, traceable, and compliant.

Packet Format Encoding for LI Headers

Packet Format Encoding describes the structure of the Lawful Interception (LI) header, which is a 32-bit construct.. This comprises four distinct fields: 3 bits for Direction, 4 bits for Packet type, 3 bits for Sub-Packet type, and 22 bits for LI ID. Each field serves a specific purpose in data transmission.

- **Direction (3 bits)**: Indicates the flow of data.
- **Packet type (4 bits)**: Specifies the kind of packet being transmitted.
- **Sub-Packet type (3 bits)**: Provides a more granular classification within a given packet type.
- **LI ID (22 bits)**: An identifier for the LI header itself.

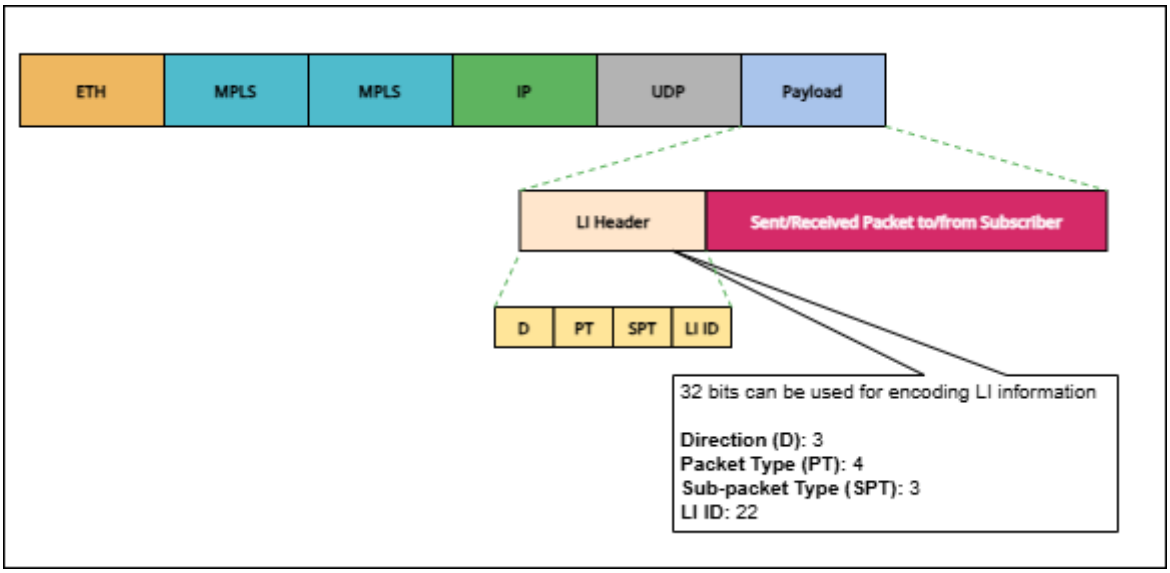


Figure 92. Packet Format Encoding

Payload Direction:

Payload Direction indicates the flow of data and has the following values:

Value	Payload Direction
1	Reserved for keepalive mechanism
2	Intercepted data or event was sent to target (downstream)
3	Intercepted data or event was sent from target (upstream)

Mapping Payload Format:

Mapping Payload Format has the following values:

Value	Payload Format
0-3	Reserved (unused)
4	Unknown, Not able to decide the PT

Value	Payload Format
5	IPv4 packet (not used)
6	IPv6 packet (not used)
7	Ethernet Frame (used for Lawful Interception)

Sub-payload Format (Type):

The sub-payload formats are used in the context of Lawful Interception (LI) to classify and manage intercepted data. These formats help in providing a more granular classification within a given packet type.

The sub-payload formats are:

- Single VLAN tag
- Double VLAN tag
- Untagged

Supported Platforms

Feature availability may vary between hardware platforms. Refer to the Platform Guide for detailed information on which features and sub-features are supported on each specific platform.

5.7.2. ETSI X1

Lawful Interception (LI) involves defined interfaces between Law Enforcement Agencies (LEAs) and Communication Service Providers (CSPs), commonly referred to as handover interfaces. Within the CSP domain, LI defines the following three interfaces:

- **X1** for interception management and administrative control
- **X2** for delivery of intercept-related information (IRI)
- **X3** for delivery of intercepted content (CC)

RBFS implements the X1 interface in compliance with **ETSI TS 101 671**. This interface is used for provisioning, modifying, and terminating interception sessions and forms the control plane between the LI management system and RBFS.

Refer to the “LIX1 Configuration” section below for details on configuring the LIX1 administration interface.

LIX1 Configuration

In this section, you will find the configurations related to the LIX1 interface.

Syntax:

set lawful-intercept protocol <protocol-name> <attribute> <value>

Attribute	Description
<protocol-name>	Enables lawful intercept on the switch. Supported Value: x1.
administrative-function-endpoint <administrative-function-endpoint>	Specifies the ADMF endpoint URL for sending requests.
administrative-function-id <administrative-function-id>	Specifies the ADMF identifier.
mediation-device-instance <mediation-device-instance>	Specifies the routing instance that hosts the mediation devices.
mutual-tls	Global mutual TLS configuration.
mutual-tls client authentication <certificate-name>	(Optional) Name of the certificate.
mutual-tls client authentication <certificate-name> certificate <certificate>	(Optional) Specifies the certificate PEM data in base64 encoding. If this value is not specified, it defaults to the server certificate.

Attribute	Description
mutual-tls client authentication <certificate-name> key-encrypted-text <key-encrypted-text>	(Optional) Specifies the Certificate key in an encrypted format.
mutual-tls client authentication <certificate-name> key-plain-text <key-plain-text>	(Optional) Specifies the Certificate key in base64 encoding. If this value is not specified, it defaults to the server authentication key.
mutual-tls client root-ca <root-ca>	(Optional) Specifies the trusted CA in base64 encoding. This is mandatory for a self-signed certificate.
mutual-tls server certificate <certificate>	Specifies the certificate PEM data in base64 encoding.
mutual-tls server client-ca <client-ca>	Specifies the trusted client CAs in base64 encoding.
mutual-tls server key <key-encrypted-text>	Specifies the certificate key in base64 encoding.
network-element-id <network-element-id>	The network element ID of the network element in the ADMF.
network-element-path <network-element-path>	(Optional) The context-path for all incoming protocol requests. Default: /X1/NE.
sync-timeout <5-60>	(Optional) The maximum interval for completing protocol requests synchronously in seconds. Default: 5.
async-timeout <10-120>	(Optional) The maximum interval for completing protocol requests asynchronously in seconds. Default: 15 seconds.

Attribute	Description
hold-time <60-86400>	(Optional) Specifies the hold time in seconds for the LI tasks if no keepalive messages are seen from ADMF. Default: 3600 seconds. If both sync and async-timeout are configured, async-timeout has to be at least twice the value of sync-timeout.

Invoking LI with CURL

As shown in the example below, you can use CURL to invoke LI.

```
sudo curl --location 'http://localhost/hostconfd/api/v1/li' --header 'Content-
Type: application/json' --data '<Insert data>'  --unix-socket
/var/run/rtbrick/hostconfd_sock/unix.sock -v
```

Enabling Lawful Interception

RBFS restricts access to lawful interception data, making it accessible only to users with the highest privilege level or to explicitly defined LI operator roles.

RBFS supports lawful interception for PPPoE, L2TP, and IPoE subscribers.

5.7.3. RADIUS Lawful Interception

RBFS supports control of Lawful Interception (LI) through RADIUS, using either the Access-Accept or Change of Authorization (CoA) messages. To initiate or manage an LI session via RADIUS, all required LI attributes must be included in the RADIUS Access-Accept or CoA request.

These attributes are salt-encrypted using the algorithm defined in RFC 2868, originally specified for the Tunnel-Password attribute. As this encryption method is defined only for Access-Accept messages, RBFS uses a modified approach for CoA compatibility: the RADIUS Request Authenticator field is replaced with 16 zero bytes. This approach is widely adopted and compatible with multiple RADIUS server implementations.

RFC and draft compliance for RADIUS-based LI is partial unless explicitly stated otherwise.

VSA 26-50058-140 - RtBrick-LI-Action (salt encrypted integer)

Value	Code	Description
NOOP	0	No action / Ignore LI request
ON	1	Start LI / Add LI request
OFF	2	Stop LI / Delete LI request

VSA 26-50058-141 - RtBrick-LI-Identifier (salt encrypted integer) Device unique lawful interception identifier (LIID) within the range from 1 to 4194303.

VSA 26-50058-142 - RtBrick-LI-Direction (salt encrypted integer)

Value	Code	Description
INGRESS	1	Ingress mirroring only (from subscriber)
EGRESS	2	Egress mirroring only (to subscriber)
BOTH	3	Bidirectional mirroring (from and to the subscriber)

VSA 26-50058-143 - RtBrick-LI-MED-Instance (salt encrypted string) The routing instance through which the mediation device is reachable.

VSA 26-50058-144 - RtBrick-LI-MED-IP (salt encrypted IPv4 address) IPv4 address of the mediation device.

VSA 26-50058-145 - RtBrick-LI-MED-Port (salt encrypted integer) UDP port between 49152 and 65535 set in the mirrored traffic

To prevent exposure of LI activity based on the presence of specific attributes, RBFS supports the special LI action NOOP. This action can be used to insert fake or decoy LI requests that have no operational effect but obfuscate detection attempts based on attribute presence alone.

For additional confidentiality, failed LI activations triggered via RADIUS do not return an error or NAK in the RADIUS response. This prevents external systems from distinguishing between valid and NOOP-based requests based on response behavior.

LI requests received via RADIUS, whether real or NOOP, are handled uniformly and appear in the same internal BDS table as requests provisioned through the X1

interface or the HTTP (REST) API.

5.7.4. RBFS Operational State API

The RBFS Operational State API provides endpoints for enabling and disabling LI on a per-subscriber basis:

- A HTTP POST request to /subscribers/{subscriber_id}/enableLI?id={li_id}&direction={li_direction}&med_ip={med_ip}&med_instance={med_instance}&med_port={med_port} enables LI for the specified subscriber
- A HTTP POST request to /subscribers/{subscriber_id}/disableLI?id={li_id} disable LI for the specified subscriber

The table below lists the request parameters:

Request Parameters

Parameter Name	Description
subscriber_id	Subscriber identifier that is generated by RBFS, for example, 72339069014638701.
id	Identifier for Lawful Interception. This is a unique Identifier used by the mediation device to identify the intercepted subscriber. The range can be between 1 to 4194303.
direction	LI direction. Values are: INGRESS, EGRESS, BOTH.
med_instance	VRF instance through which the mediation device is reachable.
med_ip	IPv4 address of the mediation device
med_port	UDP port(MD)(49152-65535), mirrored traffic is forwarded

All parameters are mandatory to enable LI.

Request Examples

Enabling LI:

The example below shows a curl command to enable LI:



Specify the element name of your system instead of {element_name} in the preceding command.

```
curl -i -H "Content-Type: application/json" -X POST
'http://198.51.100.76:19091/api/v1/rbfs/elements/\{element_name}/services/opsd/pro
xy/subscribers/72339069014639042/enableLI?id=66666&direction=BOTH&med_instance=lib
ox&med_ip=10.0.0.1&med_port=49153'
```

Disabling LI:

The example below shows a curl command to disable LI.



Specify the element name of your system instead of {element_name} in the preceding command.

```
curl -i -H "Content-Type: application/json" -X POST
'http://198.51.100.76:19091/api/v1/rbfs/elements/\{element_name}/services/opsd/pro
xy/subscribers/72339069014639042/disableLI?id=66666'
```

Response Output

The following is a sample output response for the curl command:

Output Response for enable & disable request:

```
HTTP/1.1 204 No Content
Date: Wed, 17 Sep 2025 06:23:47 GMT
Server: Python/3.10 aiohttp/3.8.1
```

In this example, the response code '204' is expected as LI request is successfully processed, but no return message will be received.

5.8. L2BSA

5.8.1. L2BSA Overview

Layer 2 Bitstream Access (L2BSA) refers to a scenario in which a service provider makes his access infrastructure available to other service providers. These are retail service providers who provide their Internet services. In Germany, this service is mandated by the Federal Network Agency (German: Bundesnetzagentur or BNetzA) which is the regulatory office for electricity, gas, telecommunications, post, and railway markets. It is a federal agency of the Federal Ministry for Economic Affairs and Energy and is headquartered in Bonn, Germany.

The definition of the L2BSA service was defined by the so-called NGA Forum, an

advisory board founded in May 2010 by the Bundesnetzagentur for promoting dialogue between the Bundesnetzagentur, network operators, manufacturers, states and local authorities on NGA rollout.

https://www.bundesnetzagentur.de/DE/Fachthemen/Telekommunikation/Breitband/NGA-Forum/start.html

The L2BSA specification defines two interfaces, the so-called U interface (User Interface) at the customer location and the A10-NSP interface (A10 Network Service Provider) between the service provider networks. Those interface types were originally introduced in the Broadband Forum TR-101 (Migration to Ethernet-based Broadband Aggregation).

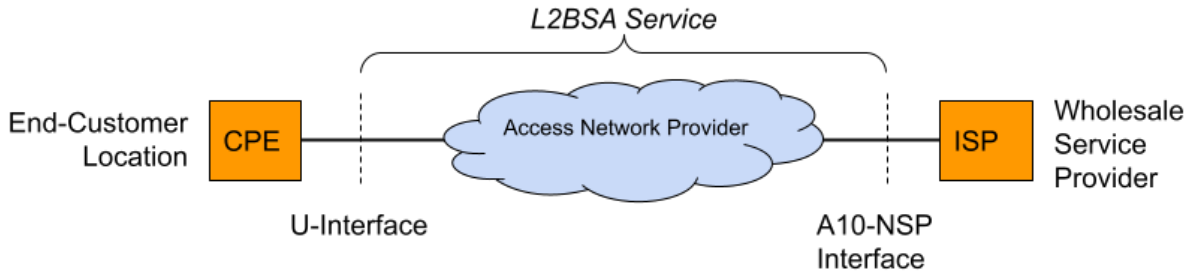


Figure 93. L2BSA Interfaces

The U interface is defined as a transparent Layer 2 interface which can be used with or without VLAN tags by the wholesale service providers. This means that some CPE will send their traffic untagged while another CPE is configured for tagged traffic which needs to be transparently forwarded between the U interface and the A10-NSP interface.

The A10-NSP interface is defined as a link aggregation bundle interface with one or more interfaces and LACP enabled or disabled. All traffic on this interface is at least single-tagged with the so-called S-VLAN tag which identifies the U interface. This limits the amount of L2BSA services to 4094 per A10-NSP interface caused by the usable VLAN range. Therefore some providers need multiple A10-NSP interfaces if they need to address more than the 4094 services.

The term A10 relates to the end-to-end ADSL network reference model depicted in the figure below. The Core Network reference model is a subset of the end-to-end architecture; it is composed of two functional blocks and three reference points. The Access Node and the Regional Broadband Network are the two functional blocks. U, V and A10 are the three reference points.

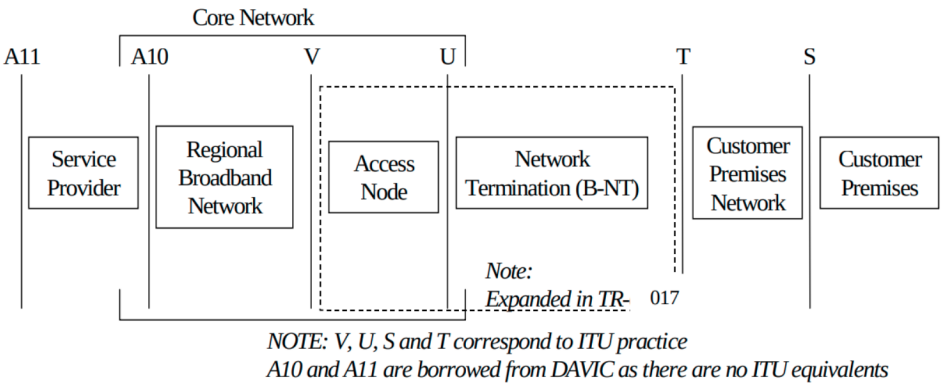


Figure 94. TR-025

Source: https://www.broadband-forum.org/download/TR-025.pdf

The mapping between the U interface and A10-NSP/S-VLAN is managed by the L2BSA service provider and typically changes frequently triggered by re-provisioning actions. Therefore all PPPoE discovery, as well as DHCPv4/v6 packets, must be enriched with additional line identification headers (Agent-Remote-Id, Agent-Circuit-Id, Actual-Data-Rate, ...) by the L2BSA service provider in the upstream direction (from U to A10-NSP interface) to allow the wholesale provider to identify the actual U interface for traffic received on the A10-NSP interface. This functionality is referred to as the intermediate agent functionality.

The U interface is terminated on the access node which might be an OLT for fiber-based access or MSAN for xDSL, therefore the U interface can also be called the customer access line or port. The access node will add additional VLAN for each access line to uniquely identify them between the access node and leaf switch. This VLAN is called the ANP tag (Access-Node-Port).

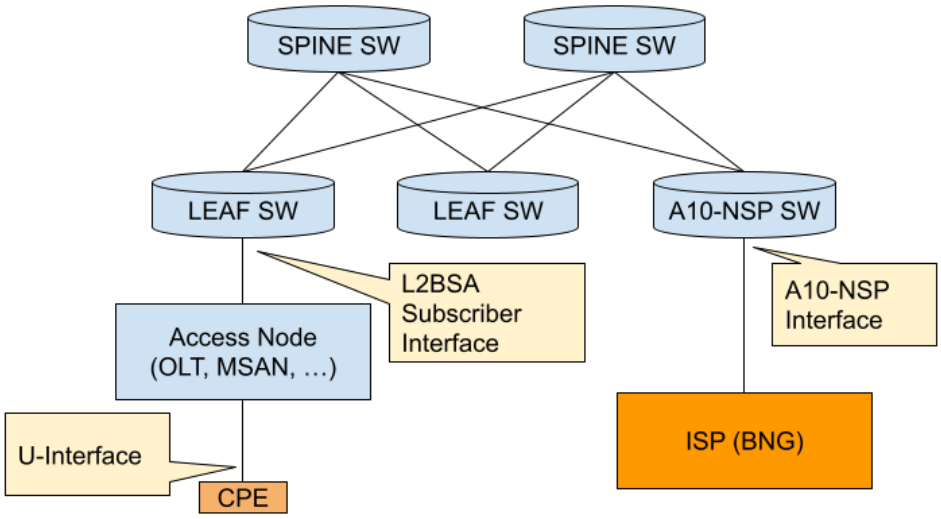


Figure 95. L2BSA Fabric

For L2BSA services all traffic received with a given ANP tag will be transparently forwarded to the corresponding A10-NSP interface via Layer 2 cross-connect (L2X) services. We introduce a new subscriber type for L2BSA in our RBFS access infrastructure to manage those services on the leaf switches and to allow further advanced access services like QoS or subscriber accounting.

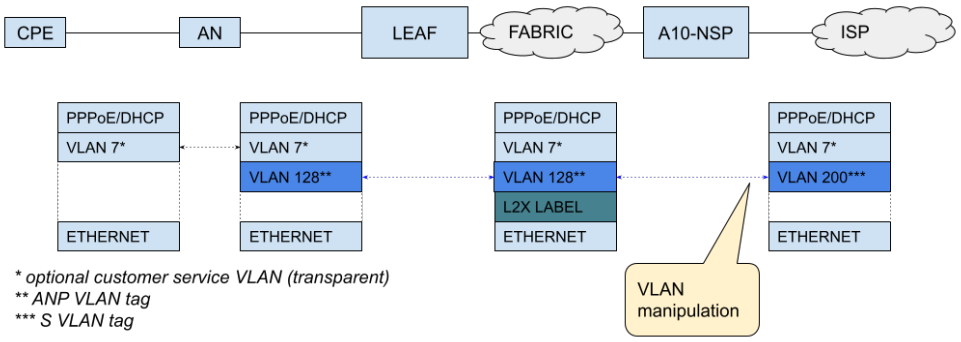


Figure 96. L2BSA Traffic

L2BSA Services and Subscribers

RBFS distinguishes between L2BSA services and subscribers. L2BSA services are created using the Operational State API (/l2bsa) stored as ephemeral objects in the configuration daemon. Those objects are excluded from the actual configuration and not restored after reboot. The L2BSA service represents a defined interface to add, update and delete L2BSA services. Those services are managed by external orchestrators or service managers and are not changed or deleted by RBFS.

Adding such an L2BSA service triggers the creation of a corresponding L2BSA subscriber which represents the internal state. Each L2BSA subscriber is a full-access subscriber and therefore most subscriber features will work for L2BSA as well. This includes features like RADIUS authentication, accounting, CoA or dynamic QoS. Each L2BSA subscriber persists as long as the service is still present and also if the subscriber has already been terminated. This allows external applications to collect all states and counters before the subscriber is finally deleted triggered by L2BSA service delete.

A10-NSP L2X Services

For each L2BSA service, there must also be an A10-NSP L2X endpoint created using the Operational State API (/a10nsp/l2x).

The A10-NSP endpoint is the place where all VLAN manipulation is done meaning

where ANP and S-VLAN are swapped.

VLAN Range Support for L2BSA Subscribers

You can use S-VLAN range for L2BSA subscribers on A10NSP (QAX) platform. It allows you to define a range of VLANs instead of configuring each VLAN separately. The related API endpoints described in the API guide.

Supported Platforms

Support for the following underlays are available:

- IS-IS Segment Routing
- BGP Segment Routing



Not all features are necessarily supported on each hardware platform. Refer to the Platform Guide for the features and the sub-features that are or are not supported by each platform.

5.8.2. L2BSA Configuration

This document assumes a working base configuration explaining the L2BSA specific additions only.

AAA Profile Configuration

Each L2BSA service refers to a mandatory AAA configuration profile as explained in detail in the Subscriber Management Configuration Guide. The following example shows the minimum configuration with authentication and accounting disabled.

```
supervisor@leaf1: cfg> show config access aaa-profile aaa-l2bsa-default
{
    "rtbrick-config:aaa-profile": [
      {
        "profile-name": "aaa-l2bsa-default",
        "authentication": {
          "order": "NONE"
        },
        "accounting": {
          "order": "NONE"
        }
      }
    ]
  }
```

5.8.3. L2BSA Operational Commands

The following commands allow to list or clear all L2BSA services from CLI.

```
supervisor@leaf1: op> show l2bsa service
Interface        ANP VLAN     Timestamp
ifp-0/0/1     1000         Mon Aug 30 09:21:14 GMT +0000 2021

supervisor@leaf1: op> clear l2bsa service all
Success
```

L2BSA subscribers can be managed like any other subscriber using the subscriber CLI commands.

```
supervisor@leaf1: op> show subscriber
Subscriber-Id          Interface        VLAN      Type   State
281479271677954        ifp-0/1/23     1000:0    L2BSA  ESTABLISHED

supervisor@leaf1: op> show subscriber filter type L2BSA
Subscriber-Id          Interface        VLAN      Type   State
281479271677954        ifp-0/1/23     1000:0    L2BSA  ESTABLISHED

supervisor@leaf1: op> show subscriber 281479271677954 detail
Subscriber-Id: 281479271677954
    Type: L2BSA
    State: ESTABLISHED
    Created: Mon Aug 30 09:23:34 GMT +0000 2021
    Interface: ifp-0/1/23
    Outer VLAN: 1000
    IFL: l2bsa-0/0/1/281479271677954
    Username: ifp-0/1/23:1000@l2bsa
    Agent-Remote-Id: DEU.L2BSA.API01
    Agent-Circuit-Id: 0.0.0.0/0.0.0.0 eth 01
    AAA-Profile: aaa-l2bsa-default
    Session-Timeout: 0 (disabled)
    Idle-Timeout: 0 (disabled)
    L2X:
        Instance: default
        Nexthop: 198.51.100.101 (ipv4/labeled-unicast)
        Ingress Label (TX): 1337
        Egress Label (RX): 7331
    Accounting:
        Session-Id: 281479271677954:1630315414
        Start-Time: 2021-08-30T09:23:34.847166+0000
        Interims Interval: 0 seconds
```

5.8.4. L2BSA Operational State API

The API is split into the L2BSA and A10-NSP L2X service API. Details about those API endpoints, schema and attributes can be found in the official RBFS Operational State OpenAPI documentation.

L2BSA Services API

Each L2BSA service is uniquely identified by physical interface name (IFP) and ANP VLAN identifier. All other attributes of L2BSA services can be changed dynamically by replacing the existing service object by doing a full update meaning that updates must include all attributes and RBFS will automatically recognize the changes to the last version to apply those incrementally.

Endpoint	Description
GET /l2bsa	This endpoint returns a list of all L2BSA services.
PUT /l2bsa	This endpoint replaces all L2BSA services on the system by adding new ones, updating existing and deleting those not included in the request but present on the system. Therefore this endpoint can be used to delete all services if an an empty list is provided in the request body.
GET /l2bsa/{ifp_name}	This endpoint returns a list of all L2BSA services on the given physical interface (IFP).
PUT /l2bsa/{ifp_name}	This endpoint works similarly to PUT /l2bsa but affects only services matching the given physical interface (IFP). Therefore this endpoint can be used to delete all services of a given physical interface if an empty list is provided in the request body.
GET /l2bsa/{ifp_name}/{anp}	This endpoint returns a single L2BSA service or 404 if no matching service is found.
PUT /l2bsa/{ifp_name}/{anp}	This endpoint adds or updates a single L2BSA service.
DELETE /l2bsa/{ifp_name}/{anp}	This endpoint deletes a single L2BSA service.

The following example shows an L2BSA service request body with only the mandatory attributes set.

```
{
    "ifp_name": "ifp-0/0/1",
    "anp_vlan": 128,
    "aaa_profile_name": "aaa-l2bsa-default",
    "l2x": {
      "ingress_nexthop": "2001:db8:0:30::",
```

```
      "ingress_service_label": 1001,
      "egress_service_label": 1002
    }
}
```

The L2X ingress next-hop is typically the fabric loopback IPv4 or IPv6 address of the corresponding switch where the corresponding A10-NSP L2X service is placed. The ingress label is the upstream service label added for traffic sent to the corresponding next-hop (sent label). The egress label is the downstream service label where traffic sent from the next-hop is expected to be received (receive label). This label must be unique per switch.



Only labels greater than 100.000 should be used for the L2X service labels because labels between 16 - 100.000 are reserved by other applications. L2X service labels must not conflict with other L2X service labels and the same label can be used for downstream and upstream.

L2BSA supports also dynamic QoS which can be controlled by RADIUS if enabled or directly via API as shown in the following example.

```
{
    "ifp_name": "ifp-0/0/1",
    "anp_vlan": 128,
    "aaa_profile_name": "aaa-l2bsa-default",
    "l2x": {
      "ingress_nexthop": "2001:db8:0:30::",
      "ingress_service_label": 1001,
      "egress_service_label": 1002
    },
    "qos": {
      "qos_profile_name": "l2bsa-qos-default",
      "parent_scheduler": "pon1",
      "shaper":
"name=shaper_session,high=14000,low=2000;name=shaper_voice,high=2000",
      "policer": "level=4,cir=1m,cbs=256;level=3,cir=2m,cbs=512",
      "queue": "name=BestEffort,size=65000;name=Voice,size=20000"
    }
}
```

The QoS configuration profile is used to instantiate the QoS resources for the subscriber including schedulers, queues and shapers. This profile can be set using the qos_profile_name attribute. All dynamic QoS settings like MFC, queue sizes, shaper and policer rates will be reset if this attribute is present also if not changed. Additional shaper or policer settings included will be applied to the new QoS configuration after reset.

The assigned shaper instances can be updated using the shaper attribute which will apply to the QoS instance of the corresponding subscriber-only, but not to the other subscribers using the same QoS profile. It is only possible to update existing shapers dynamically but it is not possible to create a new shaper.

```
"shaper": "<shaper-name>,<high-kbps>,<low-kbps>;<shaper-name>,…"
```

This attribute can be also used as a key-value list which is automatically recognized by RBFS.

```
"shaper": "name=<shaper-name>,high=<high-kbps>,low=<low-kbps>;…"
```

The policer attribute is also a string that contains a list of multiple policer-level settings separated by a semicolon. Each set contains a level, cir, cbs, pir, pbs, max-cir and max-pir separated by a comma.

```
"policer": "<level>,<cir>,<cbs>,<pir>,<pbs>,<max-cir>,<max-pir>;<level>…"

Example:
"policer": "1,2000,200;2,8000,800;3,0,800;4,0,800"

level: 1 (highest priority) to 4 (lowest priority)
cir: ingress policer committed information rate (kbps)
cbs: ingress policer committed burst size (kbps)
pir: ingress policer peak information rate (kbps)
pbs: ingress policer peak burst size (kbps)
max-cir: max ingress policer committed information rate (kbps)
max-pir: max ingress policer peak information rate (kbps)
```

If PIR and PBS are not defined, the values from CIR and CBS are used as PIR and PBS as well. The max CIR and max PIR attributes are optional default set to unlimited.

This attribute can be also used as a key-value list which is automatically recognized by RBFS.

```
"policer": "level=<level>,cir=<cir>,cbs=<cbs>,pir=<pir>,pbs=<pbs>,max-cir=<max-
cir>,max-pir=<max-pir>;…"

Example:
"policer": "level=4,cir=1m,cbs=256;cir=2m,cbs=512,level=3"
```

The queue attribute is a string that contains a list of multiple queue settings separated by a semicolon. Each queue setting contains a queue name and queue

size in bytes separated by a comma.

```
"queue": "<queue-name>,<size-bytes>;<queue-name>,<size-bytes>;…"
```

This attribute can be also used as a key-value list which is automatically recognized by RBFS.

```
"queue": "name=<queue-name>,size=<size-bytes>;name=…"
```



The subscriber management infrastructure does not check if a referenced QoS profile, shaper, queue or policer exists or not. This is handled by forwarding infrastructure which continues processing the subscriber QoS settings as soon as the missing resource was added.

The parent scheduler element of the scheduler map assigned to the subscriber can be selected with the parent_scheduler attribute. If not present, the scheduler map will be directly bound to the local IFP where the session is established. The parent scheduler can be only set at the beginning and must not be changed.



Providing a QoS parent scheduler that is not present on the corresponding IFP will lead to the black howling of all egress data traffic.

The optional access_line_info attribute contains the access line identification. A detailed list of all supported line attributes and values can be found in the official RBFS Operational State OpenAPI documentation.



For access line attributes there is a difference between attributes not present or set to zero.

Example:

```
/usr/bin/curl --location --request PUT
'http://198.51.100.35:19091/api/v1/rbfs/elements/leaf1/services/opsd/proxy/l2bsa/i
fp-0%2f0%2f1/128' --header 'Content-Type: application/json' --data-raw '{
    "ifp_name": "ifp-0/0/1",
    "anp_vlan": 128,
    "aaa_profile_name": "aaa-l2bsa-default",
    "l2x": {
        "ingress_nexthop": "2001:db8:0:30::",
        "ingress_service_label": 1001,
        "egress_service_label": 1002
    },
```

```
    "qos": {
        "qos_profile_name": "l2bsa-qos-default",
        "parent_scheduler": "pon1",
        "shaper":
"name=shaper_session,high=14000,low=2000;name=shaper_voice,high=2000",
        "policer": "level=4,cir=1m,cbs=128;level=2,cir=1m,cbs=128",
        "queue": "name=BestEffort,size=65000;name=Voice,size=20000"
    },
    "access_line_info": {
        "agent_circuit_id": "0.0.0.0/0.0.0.0 eth 0/0",
        "agent_remote_id": "DEU.RTBRICK.L2BSA01",
        "upstream": {
            "actual_rate": 2048
        },
        "downstream": {
            "actual_rate": 16235
        },
        "pon_type": "GPON"
    }
}'
```

L2BSA Subscribers API

The existing subscriber API was extended to do some common actions using the L2BSA physical interface name (IFP) and ANP VLAN identifier instead of the subscriber-id.

Endpoint	Description
GET /subscribers/l2bsa/{ifp_name}/{anp}	This endpoint is an alias for GET /subscribers/{subscriber_id} returning detailed subscriber information or 404 if no matching subscriber is found.
DELETE /subscribers/l2bsa/{ifp_name}/{anp}	This endpoint is an alias for DELETE /subscribers/{subscriber_id} which terminates a matching L2BSA subscriber.
GET /subscribers/l2bsa/{ifp_name}/{anp}/adjusted-accounting	This endpoint is an alias for GET /subscribers/{subscriber_id}/adjusted-accounting returning the adjusted accounting information or 404 if no matching subscriber is found.

A10-NSP L2X Services API

Endpoint	Description
GET /a10nsp/l2x	This endpoint returns a list of all A10-NSP L2X services.
PUT /a10nsp/l2x	This endpoint replaces all A10-NSP L2X services on the system by adding new ones, updating existing and deleting those not included in the request but present on the system. Therefore this endpoint can be used to delete all services if an an empty list is provided in the request body.
GET /a10nsp/l2x/{lag_interface_name}	This endpoint returns a list of all A10-NSP L2X services on the given the LAG interface.
PUT /a10nsp/l2x/{lag_interface_name}	This endpoint works similarly to PUT /a10nsp/l2x but affects only services matching the given LAG interface. Therefore this endpoint can be used to delete all services of a given the LAG interface if an empty list is provided in the request body.
GET /a10nsp/l2x/{lag_interface_name}/{s_anp}	This endpoint returns a single A10-NSP L2X service or 404 if no matching service is found.
PUT /a10nsp/l2x/{lag_interface_name}/{s_anp}	This endpoint adds or updates a single A10-NSP L2X service.
DELETE /a10nsp/l2x/{lag_interface_name}/{s_anp}	This endpoint deletes a single A10-NSP L2X service.

The following example shows an A10-NSP L2X service request body with only the mandatory attributes set.

```
{
    "lag_interface_name": "lag-1",
    "s_vlan": 100,
    "anp_vlan": 128,
    "l2x": {
        "ingress_nexthop": "2001:db8:0:40::",
        "ingress_service_label": 1002,
        "egress_service_label": 1001
    }
```

```
}
```

The L2X ingress next-hop is typically the fabric loopback IPv4 or IPv6 address of the corresponding switch where the corresponding L2BSA service is placed. The ingress label is the upstream service label added for traffic sent to the corresponding next-hop (send label). The egress label is the downstream service label where traffic sent from the next-hop is expected to be received (receive label). This label must be unique per switch.



Only labels greater than 100000 should be used for the L2BSA service labels because labels between 16 - 100000 are reserved by other services. L2BSA service labels must not conflict with other L2X service labels and the same label can be used for downstream and upstream.

Example:

```
/usr/bin/curl --location --request PUT
'http://198.51.100.35:19091/api/v1/rbfs/elements/a10nsp-
sw1/services/opsd/proxy/a10nsp/l2x/lag-1/100' \
--header 'Content-Type: application/json' \
--data-raw '{
    "lag_interface_name": "lag-1",
    "s_vlan": 100,
    "anp_vlan": 128,
    "l2x": {
        "ingress_nexthop": "2001:db8:0:40::",
        "ingress_service_label": 1002,
        "egress_service_label": 1001
    }
}'
```



- L2BSA supports both PPPoE and IPoE subscribers.
- L2BSA supports DHCPv4 and DHCPv6 protocols.

5.9. IPoE Subscriber Redundancy

5.9.1. IPoE Stateful Redundancy for Subscriber Groups

Overview

Node outages and link failures that may occur on an access network can bring down the subscriber services. These network outages affect critical workloads and

continuity of business. So, it is essential to set up a network that is resilient and responds quickly to the events and protects the network from outages.

The following diagram represents a simple access network without redundancy.

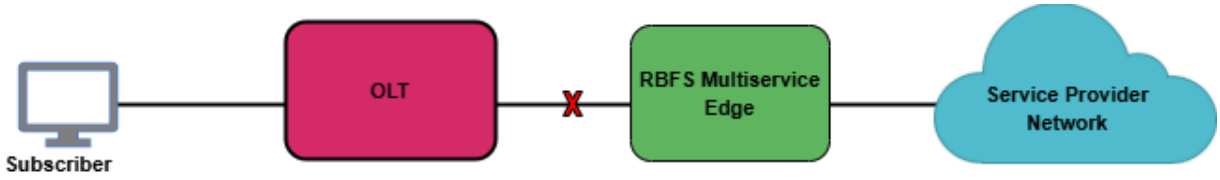


Figure 97. Access Network Without Redundancy

IPoE Stateful Redundancy protects subscriber services from node or link outages. It provides mechanisms to enhance network resiliency that enables subscriber workloads to remain functional by ensuring a reliable switchover in the event of a node or link outage. With the IPoE Stateful Redundancy, if one node goes down due to node or link failure, another node can automatically take over the services.

- RBFS currently supports stateful redundancy only for IPoE subscribers.
- The term 'Multiservice Edge' used in this document refers to a Multiservice Edge platform. The Multiservice Edge platform integrates all BNG functionalities within a single platform. In contrast, the spine-leaf topology distributes these functionalities between spine and leaf platforms based on their respective roles.
- IPoE Stateful Redundancy is supported only on Multiservice Edge platforms. IPoE Stateful Redundancy is not supported on spine-leaf network topology as the spine-leaf topology architecture itself innately provides a redundant and resilient network.

Understanding IPoE Stateful Redundancy

RBFS supports stateful redundancy and fault tolerance through two primary mechanisms:

- Active-Active Redundancy
- Active-Standby Redundancy

You can select the desired redundancy mechanism and configure the system accordingly to enable the feature. By default, the Active-Active (Standby-Forwarding) mode is enabled. If you prefer to use the Active-Standby Redundancy mode, select the Standby-Non-Forwarding option in the Platform Profile configuration. This is a one time configuration unless you choose to switch to the other Redundancy mode.

IPoE Stateful Redundancy is centered around subscriber groups, known as redundancy sessions. IPoE Stateful Redundancy protects subscriber groups using a two-node cluster model, either active-active or active-standby.

The following image illustrates two different redundancy mechanisms: Active-Active and Active-Standby. In Active-Active mode, both BNG nodes and LAGs forward traffic. In Active-Standby mode, only the active node and the LAG (between the OLT and the active node) handle traffic, while the standby node remains idle until a failover occurs.

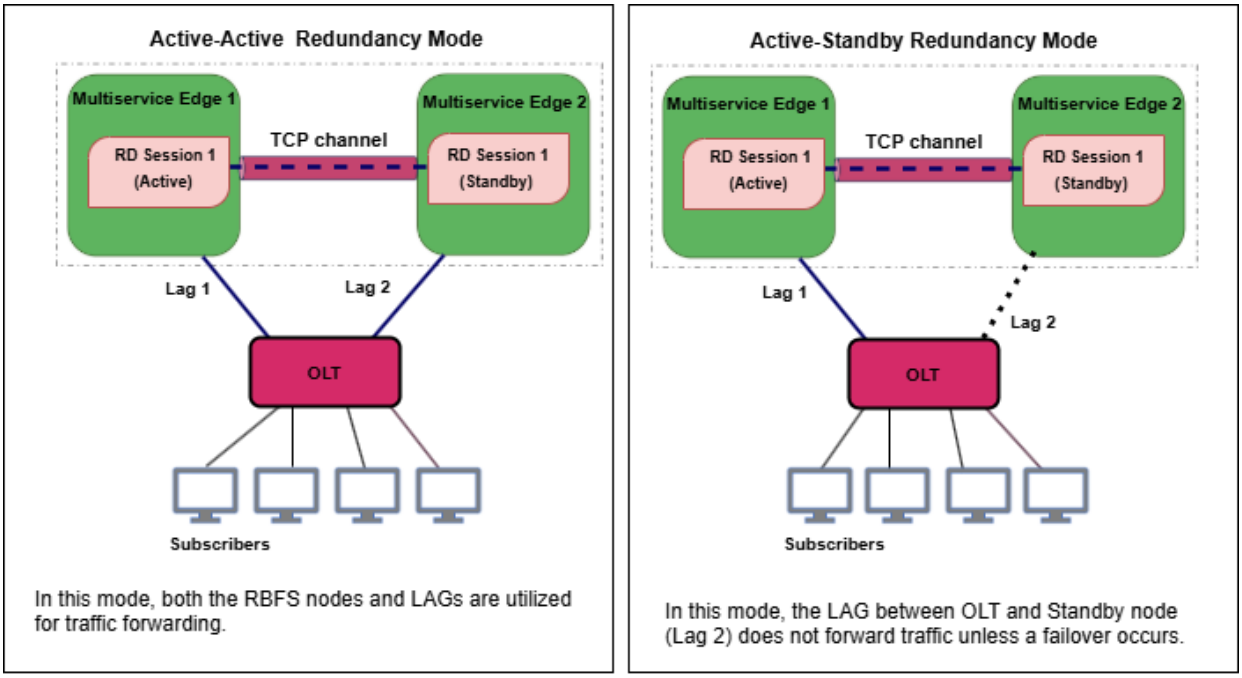


Figure 98. Active-Active and Active-Standby Redundancy Mechanisms

From the perspective of the OLT, there is only one LAG that is distributed across multiple BNGs. This means that the OLT sees one logical link, even though it is physically connected to two separate BNGs. But, in reality, this LAG spans two BNGs, indicating that the OLT is actually connected to two different devices.

Redundancy Session

Redundancy session is a replication mechanism that is used to pair Multiservice Edge nodes for redundancy. Redundancy allows grouping of subscribers, under a redundancy session and each redundancy session is represented by a redundancy session ID. Simply put, an IPoE Stateful Redundancy session represents a redundancy group of subscribers. A redundancy session enables linking the LAG with that particular redundancy session (subscriber group). When you define a value for the redundancy session ID, this ID should be unique and the same for both redundancy pairs. When two nodes get the same session ID, they recognize each other as the peer nodes for a particular redundancy session (subscriber group). The TCP session establishment between the nodes occurs after the pairing with the redundancy session ID. Once the TCP session is established, the nodes use this channel for subscriber data mirroring and synchronization and for health status monitoring.

A Multiservice Edge chassis can contain multiple redundancy sessions. Multiple Multiservice Edge nodes can be active nodes for one or more subscriber groups (redundancy sessions) that serve the subscribers and they can, at the same time, be standby nodes for other subscriber groups.

One node, which is paired for redundancy, can perform subscriber services for more than one redundancy session (subscriber group). The peer node, which is identical to the first node, contains the same subscriber group (redundancy session) as a standby. And in the event that first node goes down due to any outage, the standby node can take over subscriber service for this redundancy session.

IPoE Stateful Redundancy allows running a redundancy session actively on one node and backing up the same redundancy session (subscriber group) on a different (standby) Multiservice Edge node. In IPoE Stateful redundancy, in fact, there is no active node or standby node. It is either an active subscriber group or standby subscriber group. A Multiservice Edge node can be active for a subscriber group and at the same time it can be a standby for a different subscriber group. You can configure a maximum number of 64 redundancy sessions (either active or standby) on a Multiservice Edge node.

Active-Active Redundancy

In the Active-Active Redundancy mode, both of the nodes and their associated

LAGs are actively used for traffic forwarding. Both the nodes synchronize their subscriber state information in real-time. This ensures that all the LAG links towards the OLT are utilized for maximum resource efficiency.

If one node fails, the other node can immediately take over the responsibilities with minimal disruption, as it is already synchronized with the active node. This mechanism provides fast failover with minimal traffic disruption and ensures traffic flow.

Pinning or Assigning a Subscriber to a Link of a LAG

RBFS uses a pinning mechanism where the system assigns or 'pins' each subscriber to each of the LAG member links between active/standby nodes and the OLT.

Subscribers are assigned during session bringup to member links belonging to the access LAG on both of the nodes. They will be assigned either as locally pinned or remotely pinned. This ensures an equal distribution of subscribers across all member links.

Locally pinned: Refers to subscribers pinned to a member links of the LAG of the Active node.

Remotely pined: Refers to subscribers pinned to a member links of the LAG of the Standby node.

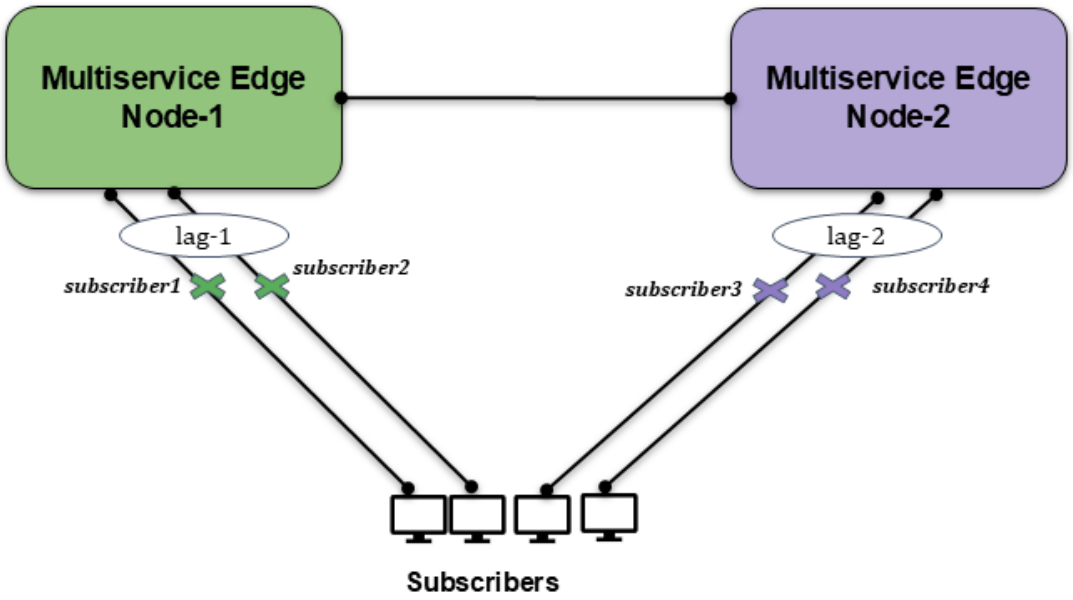


Figure 99. Pinning a Subscriber to a Link of a LAG

OLT is excluded from the diagram to simplify it and is not directly relevant to what is depicted.

The diagram illustrates the pinning mechanism, where Subscriber 1 is pinned to Link 1 of LAG 1, and Subscriber 2 is pinned to Link 2 of LAG 1. Similarly, Subscriber 3 is pinned to Link 1 of LAG 2, while Subscriber 4 is pinned to Link 2 of LAG 2.



When a member link of the access LAG fails on either the active or standby device in the Active-Active Redundancy mode, the system retriggers the subscriber pinning process to maintain an equal distribution of subscribers across the access LAG member links.

- Locally pinned subscribers will be in 'established' state on the active node and in the standby state on the Standby node.
- Remotely pinned subscribers will be in the 'established non-forwarding' state on the active node and in the 'standby-forwarding' state on the standby node.

Subscriber Pinned to Active Node

The following table provides the various subscriber state for the Active-Active Redundancy.

Subscriber Pinning	State on Active Node	State on Standby Node
Pinned to Active Node	Established	Standby
Pinned to Standby Node	Established Non-Forwarding	Standby-Forwarding

The following example shows the IPoE subscribers pinned to different LAGs and their states.

```
supervisor@rtbrick.net: cfg> show subscriber
Subscriber-Id           Interface         VLAN       Type    State
1369375761697341460     lag-1             1001:1001  IPoE    ESTABLISHED
1369375761697341463     lag-1             1001:1004  IPoE    ESTABLISHED_NO_FWD
2522297266304188429     lag-11            2001:1001  IPoE    STANDBY
2522297266304188430     lag-11            2001:1002  IPoE    STANDBY_FWD
```

The subscriber ID 1369375761697341460 is pinned to 'lag-1' and is in established state on Active node. The subscriber ID 1369375761697341463 is pinned to 'lag-1' is in a established-non-forwarding mode on the active node. The subscriber ID 2522297266304188429 is pinned to 'lag-11' and is in standby mode on the Standby node. The subscriber ID 2522297266304188430 is pinned to 'lag-11' and is in standby-forwarding mode on the Standby node.

Active-Standby Redundancy

In the active-standby node cluster, the active node (for a redundancy session) performs subscriber services. The standby device mirrors concurrent subscriber state data from the active peer (for that redundancy session). Both the nodes, paired for redundancy, keep sending 'keepalive' messages to each other to check the health status.

In this mode, the standby RBFS node does not forward traffic while the active RBFS node is functioning. The standby node stays synchronized with the active node by maintaining up-to-date routing tables, configurations, and session data, but it does not perform any traffic forwarding. If the active node fails, the standby node will take over its role and start forwarding traffic.

Active node handles all subscriber traffic and control plane processing. In this model, the standby LAG is not utilized for traffic unless a failover occurs.

IP Address Pool Management for Redundancy

There is no synchronization between local IP address pools, so an IP address on one BNG will not be reflected in the other BNG's IP address pool.

So, it is highly recommended to use RADIUS for IP address management. If local pools are used, they must be configured with disjoint address ranges across all nodes. While an IP address assigned by a pool on the active BNG can be transferred to the standby BNG during failover, the local pools are not synchronized.

Subscriber Services on Redundancy

Subscriber services refer to the various features that can be applied to subscribers, such as access control lists, HTTP redirect, lawful interception, CGNAT, IGMP, and Accounting. When deploying these services in a redundancy setup, special handling is required. The behavior of each service varies depending on whether the Redundancy mode is active-active or active-standby.

The following table provides information about the various services supported on Active-Active Redundancy and Active-Standby Redundancy.

Service	Active-Active	Active-Standby
Accounting	Supported: Both BNGs perform accounting and RADIUS aggregates counters.	Supported: Only the active BNG performs accounting.
Lawful Interception	Supported: LI must be enabled on both BNGs.	Supported: LI happens in active BNG and the data is synced to standby BNG.
HTTP Redirect	Supported: Enabled on both BNGs.	Supported: Enabled only in active BNG and synced to standby BNG.
CGNAT	Unsupported	Unsupported
Subscriber ACL	Supported: ACLs are programmed on both BNGs.	Supported: ACLs programmed only in active BNG and synced to standby BNG.

Service	Active-Active	Active-Standby
ADF (Application Detection and Filtering)	Unsupported	Unsupported
Dynamic QoS Profiles	Supported: QoS profile changes via CoA sync on both BNGs.	Supported: QoS profile changes via CoA sync to standby BNG.
Dynamic QoS Parameters	Unsupported	Unsupported
IGMP (Multicast Services)	Unsupported	Unsupported

Inter-BNG Connectivity

Multiservice Edge platforms, deployed as redundant pairs, are connected through a Redundancy session to maintain state consistency. This Redundancy session uses a TCP connection between the active and standby BNG nodes over an IP/MPLS link. TCP connection can be formed using the directly connected interfaces on the two Multiservice Edge nodes through an IP/MPLS path. The session between the Multiservice Edge nodes is used to send 'keepalive' messages and mirror data in real time. Both the active and standby BNG nodes advertise subscriber routes using the same metric.

RBFS Redundancy mechanism provides several advantages. Downstream traffic arrives either on the active or standby BNG since both advertise subscriber routes with the same metric. If the traffic arrives on the active BNG, it is delivered directly to the subscriber. If the traffic arrives at the standby BNG, it redirects the traffic to the active BNG over the inter-BNG connection.

Another advantage is that the Multiservice Edge nodes do not withdraw or re-advertise subscriber routes if an access link goes down. A link-down event on the access side does not trigger any change in route advertisements on the core side. When an access link fails, the traffic redirection from the impacted BNG to the other (redundant) BNG occurs locally and quickly without re-advertising or withdrawing routes in the core network.

In the event of a redundancy session failure, 'keepalive' messages can no longer be exchanged between the peer nodes. After the hold timer expires, the affected node transitions to a standalone operational state. All previously synchronized subscriber session data between the nodes becomes invalid.

IPoE Stateful Redundancy Architecture

The following architectural diagram provides a high-level view of IPoE stateful redundancy mode. It shows two RBFS nodes, paired for redundancy, deployed in an active-standby node cluster, with their interfaces are connected with an RD TCP connection. These peer nodes use the RD TCP connection for sending 'keepalive' messages and data mirroring for subscriber state synchronization.

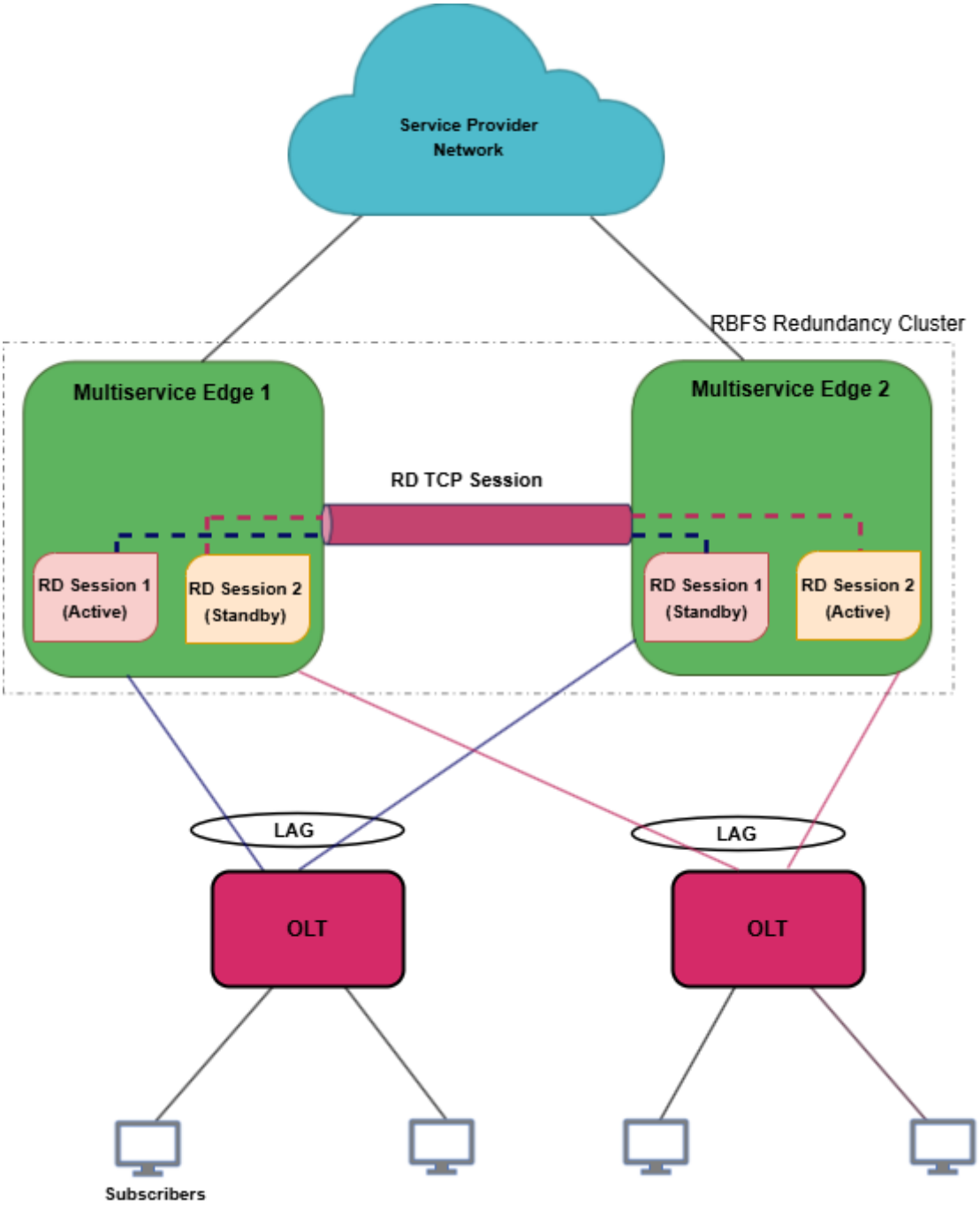


Figure 100. IPoE Stateful Redundancy Architecture

Both of the nodes are connected to an access device (OLT device in this scenario) on one end from where it receives subscriber traffic and sends traffic. The nodes

are also connected to the core network on the other end.

The node 'Multiservice Edge 1' is in active state and performs subscriber services for the 'Session 1' (redundancy subscriber group). 'Session 1' is also mirrored in the Multiservice Edge 2 in standby mode. The standby device mirrors concurrent subscriber state data for 'Session 1' from the active peer. If an active node goes down due to any reason, the peer node detects the outage and uses mirrored 'Session 1' to perform subscriber services.

One Multiservice Edge node acts as an active node for one or more sessions (subscriber redundancy groups) and as a standby Multiservice Edge for other subscriber redundancy groups at the same time. The following diagram illustrates the scenario.

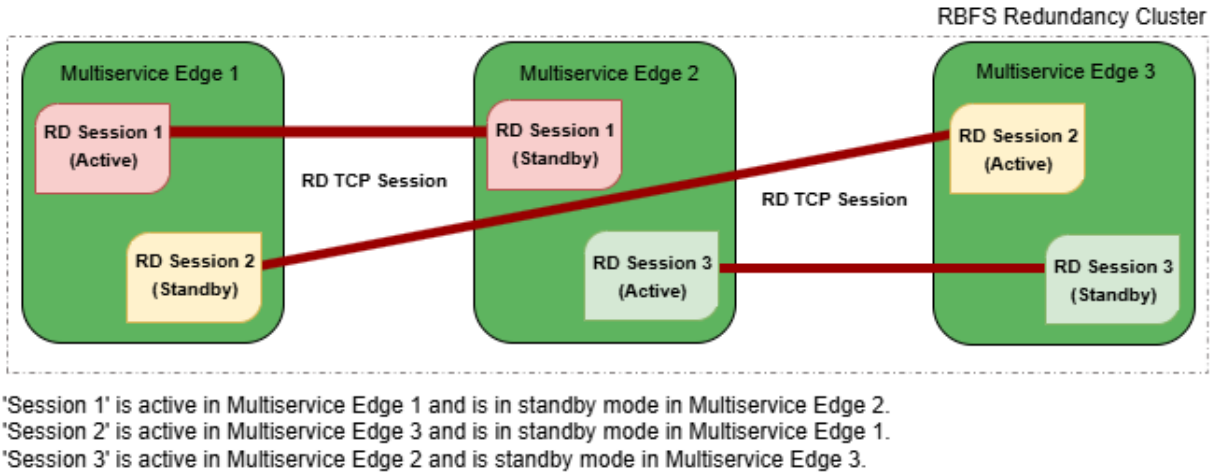


Figure 101. IPoE Stateful Redundancy

IPoE Stateful Redundancy can mitigate the following types of failures:

- Link failure Between Active RBFS Node and Access Node (OLT, DSLAM or MSAN)
- Node Outage

Redundancy for Node Outage

A node outage, which can bring down the subscriber services, can occur due to many reasons on a network. IPoE Stateful Redundancy helps to minimize the impact and reduce interruptions and downtime by providing a resilient system. In the event of a node outage, IPoE Stateful Redundancy triggers switchover in which the standby node takes over from the active node with very minimal impact on the subscriber services.

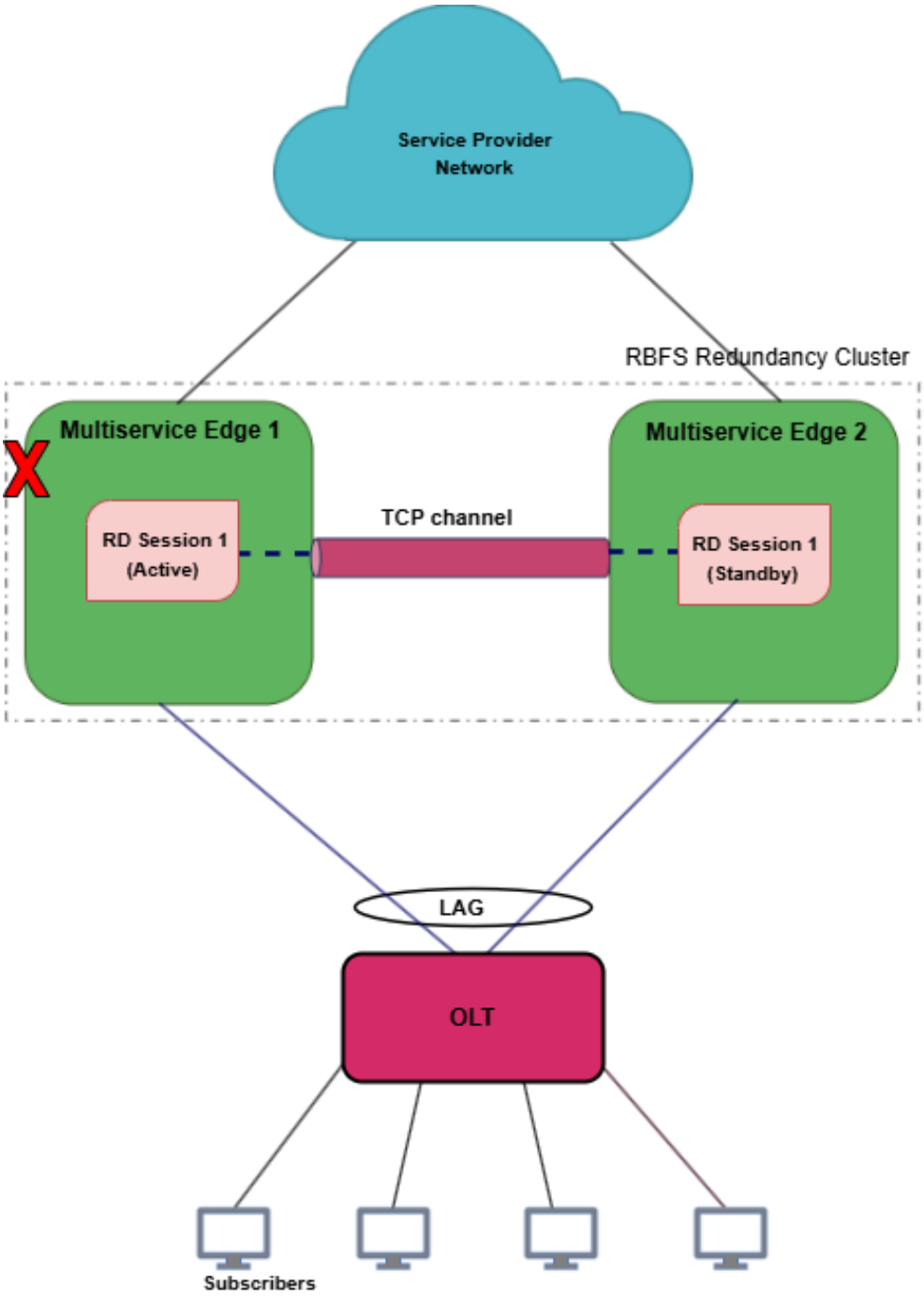


Figure 102. Node Outage Scenario

The diagram shows multiservice-edge1 as an active node serving subscribers and multiservice-edge2 stays as a standby. When an active node goes down, the standby node detects the same and takes over from the active RBFS node. In a node outage scenario, the node becomes unresponsive and cannot maintain communication with its peer node the RD TCP link.

Redundancy for Link Failure

In IPoE Stateful Redundancy, Link Aggregation combines multiple physical links

into a single logical link. If a member link, which is part of a LAG, goes down, the LAG fails. The diagram shows the 'multiservice-edge1' and 'multiservice-edge2' deployed in redundancy mode and is connected to the access device with LAGs. When the LAG between 'multiservice-edge1' and the access node goes down, the 'multiservice-edge1', which is running 'Session 1', becomes inactive for the subscriber group. So the 'multiservice-edge2', which is the standby for 'Session 1', detects the failure of 'multiservice-edge1' and starts performing subscriber services for 'Session 1' by providing a quick recovery from the disruption.

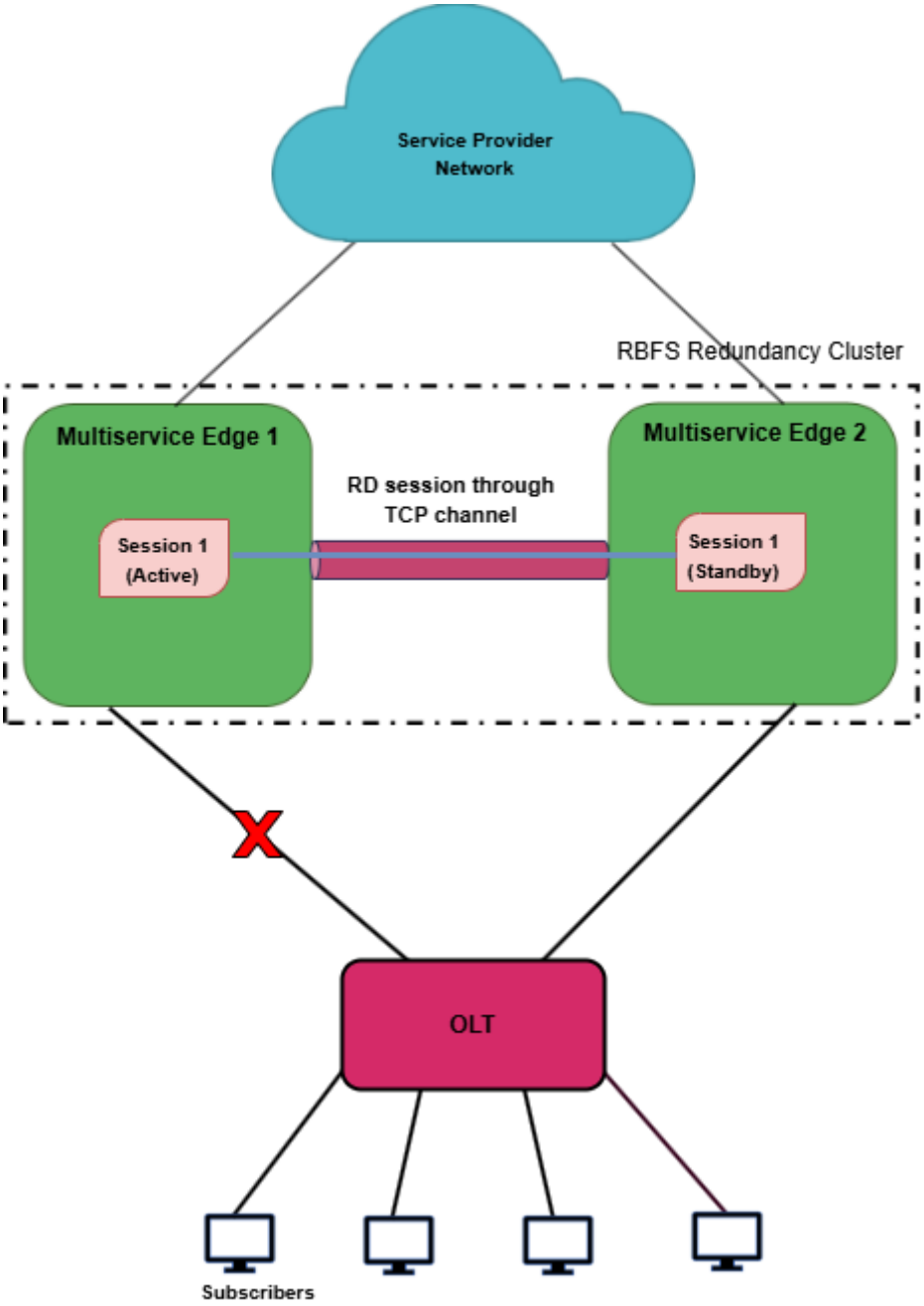


Figure 103. Link Failure Scenario

In this link or LAG failure scenario, multiservice-edge1 is in a healthy state, only the

LAG interface went down. It cannot perform subscriber services for the particular redundancy session. However, it can keep communication with its peer node as the RD TCP channel.

Node States in Redundancy

In IPoE Stateful redundancy, Multiservice Edge nodes have different states for various redundancy sessions. Typically, IPoE Stateful redundancy nodes encounter the following states for redundancy sessions:

Active: All subscribers are served by active node in the RBFS active-standby node cluster. One node which is active for a redundancy session can be a standby node for a different session. Nodes, that are paired for redundancy, send 'keepalive' messages to each other and also synchronize all subscriber state data with the peer node. The priority values that you specify for the redundancy nodes determine the roles of active and standby. The node that receives the higher priority value for the session ID assumes the role of active for that subscriber group. To set one device as 'active', you must specify higher priority value for the redundancy session for that node.

Standby: Standby node is identical with the active node and synchronizes subscriber data concurrently from peer node. It keeps communication with the peer node to monitor node health status using 'keepalive' messages. The node that gets the lower priority value for the redundancy session ID assumes the role of standby. Standby node for a subscriber group does not perform any subscriber services for that group unless or until the active node encounters an outage.

Down: When a node becomes inactive due to an outage, it is considered as 'down'. In the event of a node outage, it is completely down and cannot perform subscriber services and any communication with its peer node. But in the case of a LAG (between the node and access node) failure, the node cannot perform subscriber services, but it can communicate with the peer node through the RD TCP connection. So that the subscriber state synchronization occurs without any interruption.

Stand Alone: When the active node goes down, the switchover occurs and standby takes over the subscriber service. In this scenario, the serving node is in 'stand alone' state (for that redundancy session) as it has no peer node for redundancy.

Revert or Rollback Active-Standby Redundancy Mode

In IPoE Stateful Redundancy, after a node or link failure and the subsequent switchover, the standby takes over and continues the subscriber service for that subscriber group even after the other node (previously active) recovers from the failure. There is no automated rollback or revert to the previously active router. However, administrators can perform a manual switchover for the Active-Standby Redundancy mode.

Monitoring Node Health Status

The RBFS nodes, which have switchover capacities, monitor each other for the health status. IPoE Stateful Redundancy uses 'keepalive' messages that check on the health of the RBFS nodes. Both of the devices send 'keepalive' messages to each other in every five seconds. One Node can detect a failure if it does not receive 'keepalive' messages for a period of 20 seconds from the other node.

Redundancy Clients

There are multiple RBFS daemons that participate in providing redundancy. They include redundancy daemon, (rd), LAG daemon (lagd), interface daemon (ifmd), subscriber daemon (subscriberd), IPoE daemon (ipoed) and forwarding daemon (fibd). These daemons, which perform various roles, are known as redundancy clients.

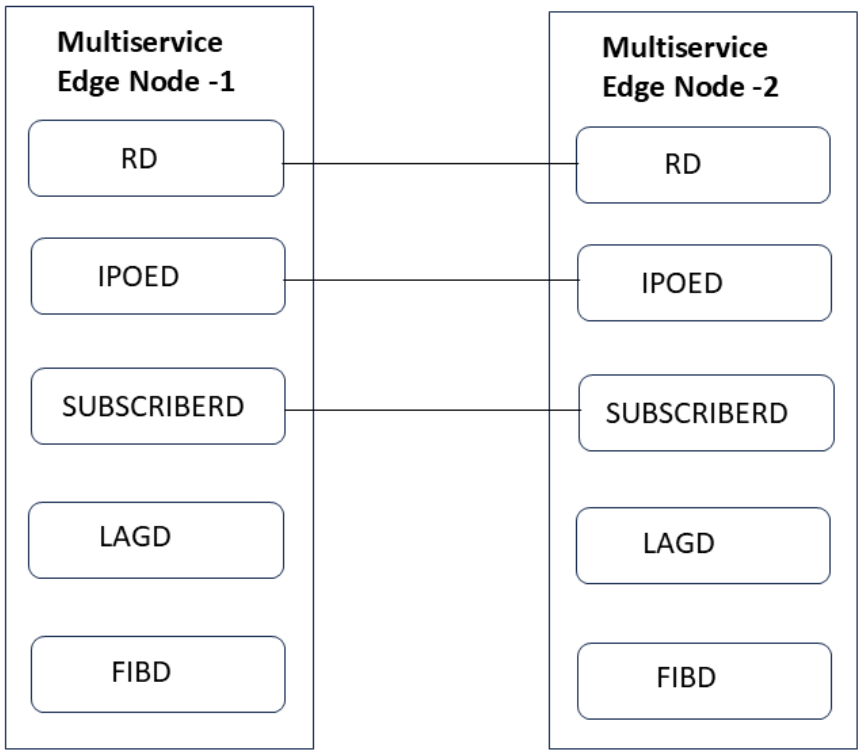


Figure 104. Redundancy Clients

Redundancy in DHCP Relay Mode

RBFS supports IPoE Stateful Redundancy in both DHCPv4 and DHCPv6 relay modes. RBFS can maintain synchronized IPoE session states across redundant Multiservice Edge nodes operating in 'relay' mode.



In DHCP Relay mode, source address configured for DHCP server on both of the Multiservice Edge nodes should be different, and the proxy-ARP "any" should be enabled.

Redundancy Daemon

Redundancy Daemon is responsible for establishing high-availability connections. It monitors the ecosystem and detects any outages that may happen on the network. It assigns the roles of active or standby to the nodes depending on the priority configured on the node. The daemon triggers a switchover to the standby node if a failure occurs. It responds to the failure events which are reported locally by daemons who are the redundancy clients. It also reconciles the data after switchover from the node that went down.

Supported Hardware Platforms

Currently, RBFS can be deployed in redundancy mode using the RBFS Multiservice Edge switches. Multiservice Edge software provides complete BNG functionalities on a single compact hardware switch. Both the Active-Active Redundancy and Active-Standby Redundancy modes are supported in the following hardware platforms:

- UfiSpace S9600-72XC: The UfiSpace S9600-72XC is a multi-function, disaggregated white box aggregation routing platform that is equipped with Broadcom's Qumran2c chipset. It features 64x25GE and 8x100GE high-speed ports with a switching capacity of up to 2.4Tbs.
- Edgecore AGR420: AGR420 is a high performance 25GbE aggregation router that consists of fixed 64 x 10G/25G SFP28, 8 x 100GE QSFP28 and 2 x 100G QSFP-DD network interface configurations.

Only Active-Standby Mode is supported on the following platforms:

- Edgecore CSR440
- UfiSpace S9510-28DC

IPoE Stateful Redundancy Requirements

The following are the requirements for setting up Redundancy.

- Ensure that both of the platform devices, on which RBFS software runs, must be the same model.
- Ensure that the devices should run the same version of RBFS software. RBFS software 23.2.1 and later versions support Active-Standby redundancy mode and 25.1.1 and later versions support Active-Active Redundancy mode.
- NTP must be configured on both devices to match the timestamps.

5.9.2. Deploying Multiservice Edge in Redundancy Mode

Redundancy

This section provides information on how to deploy Multiservice Edge device pair to achieve redundancy. The following workflow diagram depicts the end-to-end deployment of Multiservice Edge in Redundancy mode:

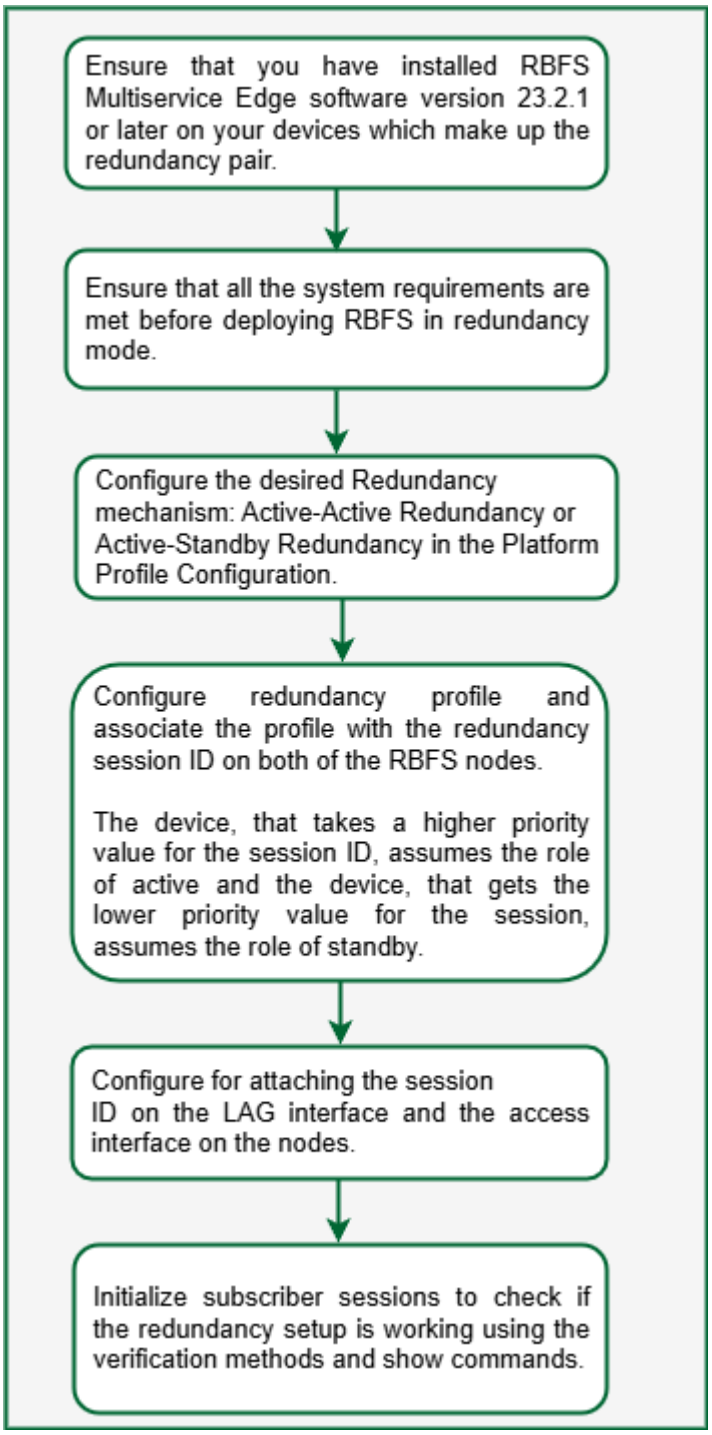


Figure 105. Workflow for Multiservice Edge in Redundancy Mode

You must perform the following tasks to deploy the RBFS devices in redundancy mode. These configurations must be performed on both of the devices.

1. Set up the Redundancy Mode: Standby Forwarding or Standby Non-Forwarding.
2. Configure Redundancy Profile
3. Configure Session for Redundancy

4. Configure Link Aggregation Group for Redundancy
5. Configure Access for Redundancy

Configuration Syntax and Commands

The following sections describe syntax and commands for various configurations.

Setting up the Redundancy Mode

You can choose your preferred redundancy mechanism and set up the system to enable it. Redundancy is available in two modes: Standby Forwarding and Standby Non-Forwarding. By default, the Standby Forwarding method is enabled. If you would like to use the Standby Non-Forwarding mode instead, you need to select the Standby Non-Forwarding option in the Platform Profile configuration.



This setup is a one-time activity and system reboot is required the changes to take effect.

To set the desired redundancy mode, use the command.

Syntax:

set system platform profile <profile-name> **redundancy-mode** [**Standby-Forwarding** | **Standby-Non-Forwarding**]

Attribute	Description
standby-forwarding	Active-Active redundancy mode. Redundancy mode in which the standby LAG is utilized for traffic forwarding.
standby-non-forwarding	Active-Standby Redundancy mode. Redundancy mode in which Standby node LAG does not forward traffic unless a failover occurs.

Example:

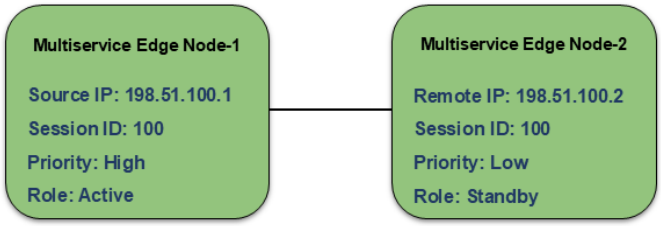
```
supervisor@rtbrick.net: cfg> show config system platform profile
{
  "rtbrick-config:profile": [
    {
      "profile_name": "nat_4q",
```

```
      "redundancy-mode": "standby-non-forwarding"
    }
  ]
}
```

For more information about Platform Profile, see section Platform Profile Support.

Configuring Redundancy Profile

Redundancy profile configuration is used to provide peer identity in redundancy. While configuring the redundancy profile on the nodes, you need to specify IP addresses of both the peer nodes. Based on the priority value that you specify for the session ID, the peers take the roles of active and standby for the Session.



Syntax:

set redundancy profile <name>

Attribute	Description
peer	Redundancy configuration
switchover-hold-timer	Minimum time interval between consecutive switch-overs in seconds.

Run the following commands to configure redundancy profile.

```
set redundancy profile rd_ipoe
set redundancy profile rd_ipoe peer ipv4 remote-address 198.51.100.2
set redundancy profile rd_ipoe peer ipv4 update-source 198.51.100.1
set redundancy profile rd_ipoe peer ipv4 instance default
```

Example Configuration:

```
supervisor@rtbrick>cbng1.rtbrick.net: cfg> show config redundancy profile
{
    "rtbrick-config:profile": [
```

```
      {
        "name": "rd_ipoe",
        "peer": {
          "ipv4": {
            "remote-address": "198.51.100.2",
            "update-source": "198.51.100.1",
            "instance": "default"
          }
        }
      }
    ]
  }
```

To access the RESTCONF API that corresponds to this CLI, click here.

Configuring Session for Redundancy

You can configure Redundancy Session with a unique session ID. You can define the system priority value (which determines active and standby roles) and the associate Redundancy profile configuration in the Redundancy Session configuration.

Syntax:

set redundancy session <session-id>

Attribute	Description
keepalive-interval	Keepalive message transmission interval in seconds. Default is 5 seconds.
priority	Session priority
profile	Profile name

Run the following commands to configure session for redundancy.

```
set redundancy session 100
set redundancy session 100 priority 10
set redundancy session 100 profile rd_ipoe
```

Configuration Example:

```
supervisor@rtbrick>cbng2.rtbrick.net: cfg> show config redundancy session
{
    "rtbrick-config:session": [
```

```
      {
        "session-id": 100,
        "priority": 10,
        "profile": "rd_ipoe"
      }
    ]
  }
```

To access the RESTCONF API that corresponds to this CLI, click here.

Configuring LAG for Redundancy

You must associate the Redundancy Session with the LAG. While configuring LAG for redundancy, you must specify the session ID to associate the LAG with the Redundancy Session. LAG can identify its Redundancy Session with this mapping.

Syntax:

set link-aggregation interface <interface-name> **options**

Attribute	Description
description	Link aggregation interface description.
member-interface	Link aggregation member interface configuration
minimum-link-count	Minimum number of active member links required for the link aggregation interface. default values is 1.
mode	Mode of the link aggregation interface, static or lacp. default mode is lacp.
rd-role	Role of the link aggregation interface, active or standby.
rd-system-priority	The value for the system priority range from 1 to 65535. The lower the value, the higher the system priority. default value is 65535.
redundancy-session-id	The value for the redundancy group session id range from 1 to 65535.
system-id	Redundancy System ID of link-aggregation interface.

Run the following commands to configure LAG for redundancy.

```
set link-aggregation interface lag-1
set link-aggregation interface lag-1 mode lacp
set link-aggregation interface lag-1 minimum-link-count 1
set link-aggregation interface lag-1 redundancy-session-id 100
set link-aggregation interface lag-1 system-id a8:b5:7e:8f:66:43
set link-aggregation interface lag-1 member-interface ifp-0/1/260
```

Example Configuration:

```
supervisor@rtbrick>cbng2.rtbrick.net:: cfg> show config link-aggregation interface
lag-1
{
    "rtbrick-config:interface": [
      {
        "interface-name": "lag-1",
        "mode": "lacp",
        "minimum-link-count": 1,
        "redundancy-session-id": 100,
        "system-id": "11:22:33:44:55:66",
        "member-interface": [
          {
            "member-interface-name": "ifp-0/0/4"
          }
        ]
      }
    ]
  }
```

API To access the RESTCONF API that corresponds to this CLI, click here.

Configuring Access for Redundancy

IPoE and Redundancy Session mapping is essential to associate the Redundancy Session with IPoE. While configuring access for redundancy, you must specify access type as IPoE.

Syntax:

set access interface double-tagged <name> <options>

Attribute	Description
aaa-profile-name	AAA profile name
access-profile-name	Access profile name
access-type	Access service type

Attribute	Description
gateway-ifl	IPoE gateway IFL (unnumbered source IFL)
max-subscribers-per-mac	Restrict maximum subscribers per MAC address
max-subscribers-per-vlan	Restrict maximum subscribers per VLAN
redundancy-session-id	Redundancy session id for this interface
service-profile-name	Service profile name
vlan-profile-enable	Enable VLAN profiles

Run the following commands access for redundancy.

```
set access interface double-tagged lag-1 1001 1100 1001 1100
set access interface double-tagged lag-1 1001 1100 1001 1100 access-type IPoE
set access interface double-tagged lag-1 1001 1100 1001 1100 access-profile-name
ipoe
set access interface double-tagged lag-1 1001 1100 1001 1100 aaa-profile-name
ipoe-aaa
set access interface double-tagged lag-1 1001 1100 1001 1100 gateway-ifl lo-
0/0/0/10
set access interface double-tagged lag-1 1001 1100 1001 1100 redundancy-session-id
100
```

Example Configuration:

```
supervisor@rtbrick>cbng1.rtbrick.net: cfg> show config access interface double-
tagged lag-1
{
    "rtbrick-config:double-tagged": [
      {
        "interface-name": "lag-1",
        "outer-vlan-min": 1001,
        "outer-vlan-max": 1100,
        "inner-vlan-min": 1001,
        "inner-vlan-max": 1100,
        "access-type": "IPoE",
        "access-profile-name": "ipoe",
        "aaa-profile-name": "ipoe-aaa",
        "gateway-ifl": "lo-0/0/0/10",
        "redundancy-session-id": 100
      }
    ]
  }
```

API To access the RESTCONF API that corresponds to this CLI, click here.

Switchover Manually

In the Active-Standby redundancy mode, administrators can perform a manual switchover from an active node to a standby node. Use the following command to perform switchover:

```
switch-over session <session-id> confirm
```

5.9.3. RBFS Redundancy Operational Commands

Redundancy Show Commands

With the RBFS Command Line Interface, you can view output of operational commands. The redundancy operational commands provide detailed information about the RBFS redundancy operations.

Redundancy Details

Syntax:

show redundancy <options>

Option	Description
client	Displays information about redundancy client daemons.
session	Displays session details.

Client Statistics

Syntax:

show redundancy client <name> **statistics**

This command displays information from redundancy client (daemon) which is a participant in the redundancy sessions. The daemons ifmd, ipoed.1, lagd, and subscriberd.1 are the client daemons in redundancy sessions.

Command:

```
show redundancy client lagd statistics
```

Example:

```
supervisor@rtbrick>ufi08.q2c.u23.r4.nbg.rtbrick.net: op> show redundancy client
lagd statistics
Session id: 100, Profile: rd_ipoe
  Agent State: down
  TCP operational state: down
  Message statistics:
    Keep alive sent: 0
    Keep alive received: 0
  Last 5 state changes: [Latest first]
    down                : 2022-12-08T08:47:06.077823+0000
    demote-ready        : 2022-12-08T08:47:06.077798+0000
    demote-infra-wait   : 2022-12-08T08:47:06.077769+0000
    demote-app-wait     : 2022-12-08T08:47:06.077713+0000
    active              : 2022-12-08T06:57:53.058172+0000
  Connection statistics:
    Peer Address: 198.51.100.2
    Application down notifications: 0
    Connection down notifications: 0
    Retry count: 0
    Session down received: 8
```

Redundancy Session Details

Syntax:

show redundancy session <id> <options>

Option	Description
-	Without any option, it displays all session details.
detail	Displays details session information.
history	Displays session history.
status	Displays session status.

Example:

```
supervisor@rtbrick.net: op> show redundancy session detail
Redundancy session ID: 100, Update source: 198.51.100.1, Peer: 198.51.100.2.
  Instance: default, Profile name: rd_ipoe, Local priority: 20
```

```
  State: down, Previous state: active, Last state transition time: 2022-12-
08T08:47:06.071930+0000
  TCP operational state: down
  Message statistics:
    Keep alive sent: 21516
    Keep alive received: 21515
    Switch overs detected: 0
  Timers:
    Connect retry interval: 2000
    keep alive timer interval: 3000
    Holddown timer interval: 9000
```

Example: RD session detail for a session ID.

```
supervisor@rtbrick.net: op> show redundancy session 100 detail
Redundancy session ID: 100, Update source: 198.51.100.1, Peer: 198.51.100.2
  Instance: default, Profile name: rd_ipoe, Local priority: 20
  State: down, Previous state: active, Last state transition time: 2022-12-
08T08:47:06.071930+0000
  TCP operational state: down
  Message statistics:
    Keep alive sent: 21516
    Keep alive received: 21515
    Switch overs detected: 0
  Timers:
    Connect retry interval: 2000
    keep alive timer interval: 3000
    Holddown timer interval: 9000
```

Example: Status information of a session specified

```
supervisor@rtbrick.net: op> show redundancy session 100 status
State: down,  Remote State: invalid
Redundancy client replication information:
  Total redundancy clients : 5
  ifmd:
  ipoed.1:
  lagd:
  poold:
  subscriberd.1:
    Number of subscribed table: 1
```

Example: History of a session ID for a specified count.

```
supervisor@rtbrick.net: cfg> show redundancy session 100 history count 3
Previous state       Current state        State change reason  Timestamp
connect              standby              standby              2022-12-
21T07:05:36.010847+0000
down                 connect              open                 2022-12-
21T07:05:29.738121+0000
invalid              down                 init                 2022-12-
21T07:00:44.282300+0000
```

5.10. PPPoE Subscriber Redundancy

5.10.1. RBFS Stateless Redundancy for PPPoE Subscribers

Overview

RBFS supports Redundancy for PPPoE subscribers to maintain service continuity during node or link failures. The Redundancy is based on a deterministic active-standby BNG architecture, where only one BNG node actively establishes, maintains and terminates subscriber sessions. The standby BNG node remains idle and ready to take over if there is a failure on the active BNG node.

Subscriber traffic is managed exclusively by the active BNG node and the standby node continuously monitor the health of the active node. PPPoE Redundancy does not synchronize subscriber session state between the active and standby nodes. When a failure occurs, the standby node promotes itself to the active role based on health monitoring mechanism.

When an outage occurs on the active node, all existing PPPoE sessions on that node are terminated. Affected subscribers are required to re-initiate PPPoE discovery and authentication. Subscriber services are restored by establishing new PPPoE sessions on the standby node (standalone) that becomes active. Subscribers, re-onboarded on the new standby node, are assigned a new IP address from its local pool. As a result, downstream traffic is redirected to the new active node without any route advertisements or withdrawals.



- The term 'Multiservice Edge' used in this document refers to an RBFS BNG platform that performs the Multiservice Edge role. The Multiservice Edge role integrates all BNG functionalities within a single platform. In contrast, the spine-leaf architecture distributes these functionalities between spine and leaf platforms based on their respective roles.

Understanding Redundancy for PPPoE Subscribers

Inter-BNG Connectivity and Redundancy Session

The BNG nodes configured as a redundancy pair maintain a redundancy session over an TCP connection through an IP/MPLS link. TCP connection can be formed using the directly connected interfaces or via an IP/MPLS path through core

network. This communication channel is used by the standby node to continuously monitor the health state of the active node. The redundancy session remains established as long as the TCP connection is available. The session between the nodes is used to send 'keepalive' messages to check the node health. In the event of a failure on the active node, the standby node detects the failure through this channel and initiates the failover.

Every redundancy session is represented by a redundancy session ID. When you define a value for the redundancy session ID, this ID should be unique within the redundancy group or domain and must be configured with the same value on both nodes (active and standby) participating in that redundancy session. When two nodes get the same session ID, they recognize each other as the peer nodes for a particular redundancy session.

From the perspective of the OLT, there is only one active-standby LAG that is distributed across multiple BNGs. This means that the OLT sees one logical link, even though it is physically connected to two separate BNGs.

PPPoE Stateless Redundancy Architecture

The following architectural diagram provides a high-level view of PPPoE redundancy mode. It shows two RBFS nodes, paired for redundancy, deployed in an active-standby node cluster, with their interfaces are connected with an TCP connection.

Both nodes are connected to an OLT device on southbound (access) side, through which they receive and forward subscriber traffic. On the northbound side, the nodes are connected to the core network for upstream and downstream communication.

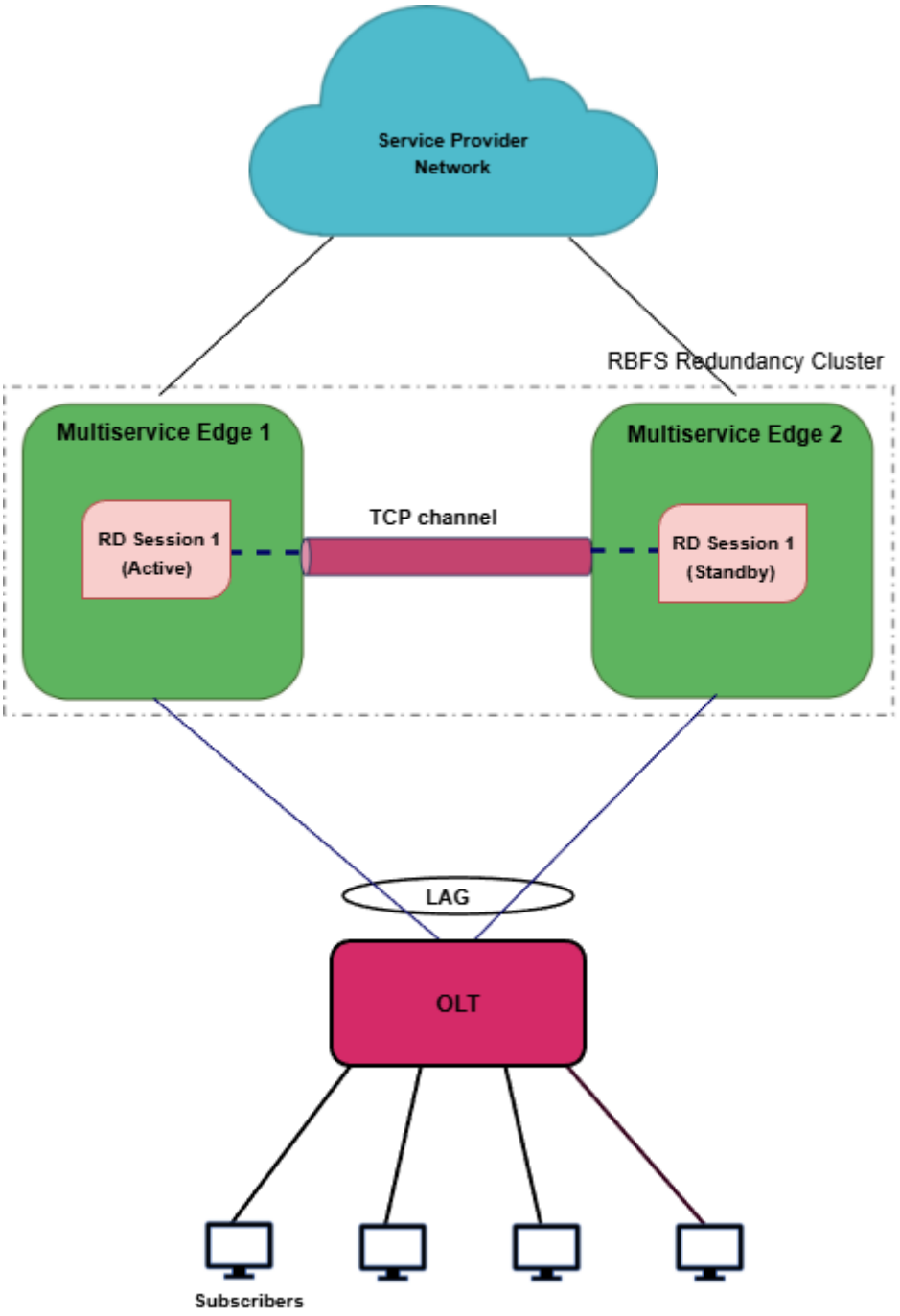


Figure 106. PPPoE Redundancy Architecture

PPPoE Redundancy can mitigate the following types of failures:

- Link failure Between Active RBFS Node and Access Node (OLT, DSLAM or MSAN)
- Active Node Outage

Redundancy for Node Outage

When the active BNG node fails, the standby node detects the failure through

health-state monitoring maintained by the redundancy session. The standby node then transitions to standalone mode, activates the LAG, and re-onboards subscribers. The following diagram illustrates a node outage scenario.

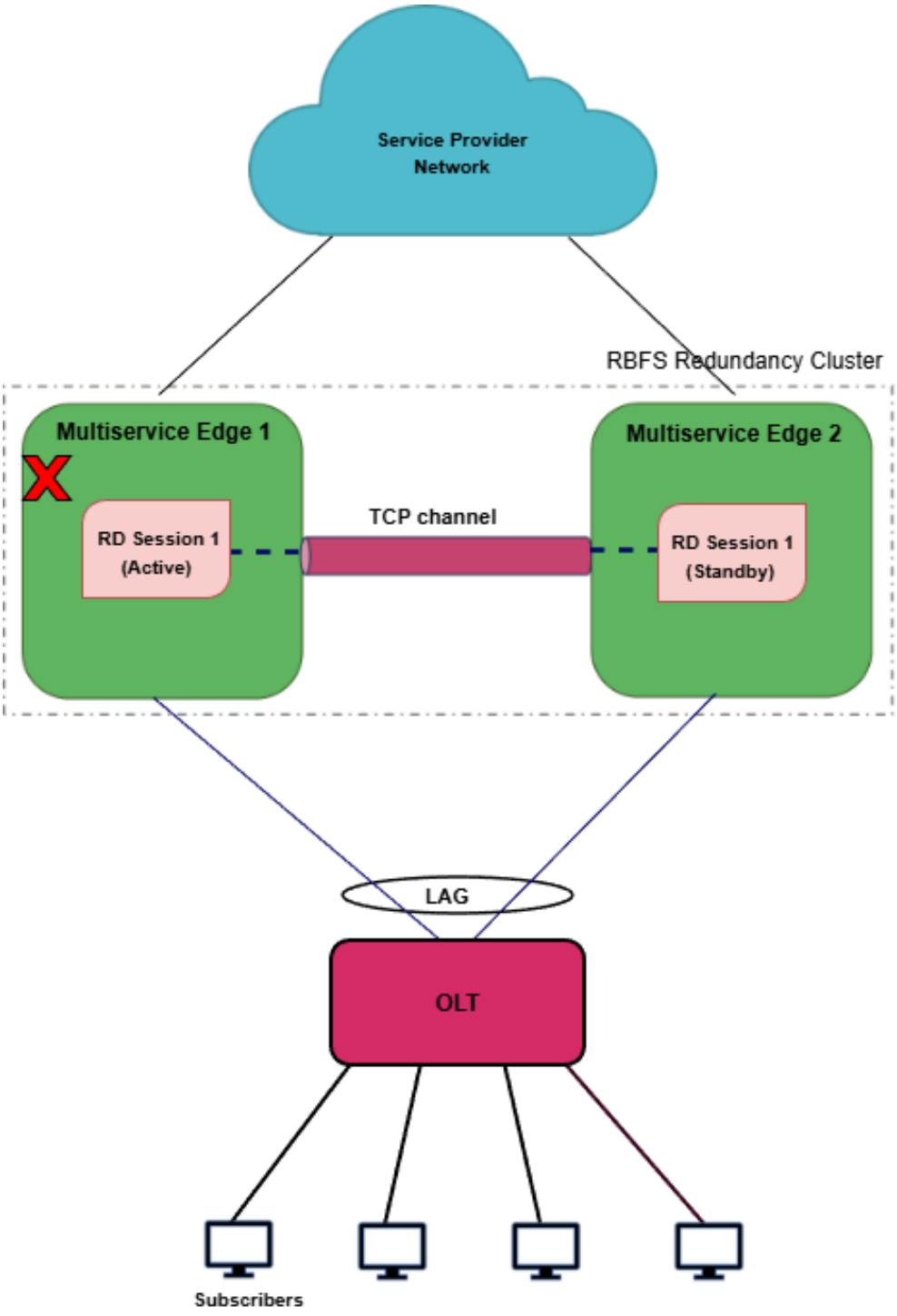


Figure 107. Node Outage Scenario

Redundancy for Link Failure

A LAG is considered down when the number of member links falls below the configured minimum link threshold. When this occurs, the affected node can no

longer serve subscriber traffic. The standby node detects the failure through the TCP connection and initiates failover by re-onboarding subscribers and establishing new sessions. The following illustration depicts a LAG failure scenario in which the active LAG between the 'multiservice-edge1' node and the OLT device goes down.

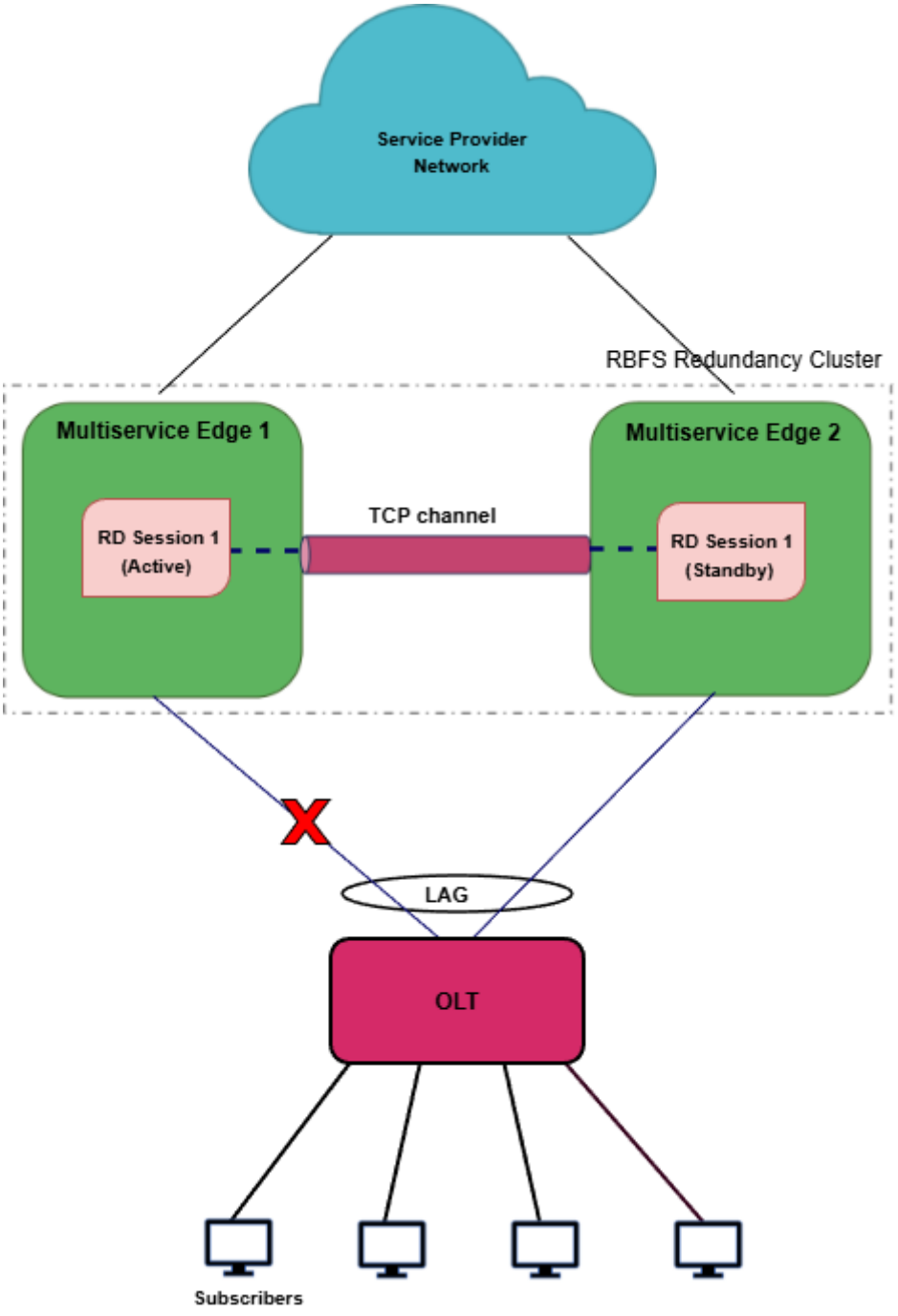


Figure 108. Link Failure Scenario

Node States in PPPoE Redundancy

Multiservice Edge nodes have different states for various redundancy sessions.

Active: All subscribers are served by active node in the RBFS active-standby node cluster. One node which is active for a redundancy session can be a standby node for a different session. The priority values that you specify for the redundancy nodes determine the roles of active and standby. The node that receives the higher priority value for the session ID assumes the role of active for that subscriber group.

Standby: Standby node keeps communication with the active BNG node to monitor node health status using the 'keepalive' messages. The node that gets the lower priority value for the redundancy session ID assumes the role of standby. Standby node for a subscriber group does not perform any subscriber services for that group unless or until the active node encounters an outage.

Down: When a node becomes inactive due to an outage, it is considered as 'down'. In the event of a node outage, it is completely down and cannot perform subscriber services and any communication with its peer node. But in the case of a LAG (between the node and access node) failure, the node cannot perform subscriber services, but it can communicate with the peer node through the RD TCP connection.

Stand Alone: When the active node goes down, the switchover occurs and standby takes over the subscriber service. In this scenario, the serving node is in 'stand alone' state (for that redundancy session) as it has no peer node for redundancy.

Supported Hardware Platforms

Currently, RBFS can be deployed in redundancy mode for the PPPoE subscribers using the following RBFS Multiservice Edge platforms.

- UfiSpace S9600-72XC
- UfiSpace S9600-102XC
- UfiSpace S9510-28DC
- Edgecore CSR440 (AS7535-28XB)

Additional Requirements for PPPoE Redundancy

The following are additional requirements which must be met before setting up Redundancy.

- Ensure that both of the platform devices, on which RBFS software runs, must be the same model.
- Ensure that the devices should run the same version of RBFS software. RBFS software 25.4.1 and later versions support Active-Standby redundancy mode for PPPoE subscribers.
- NTP must be configured on both devices to match the timestamps.

5.10.2. Configuring Redundancy for PPPoE Subscribers

Configuration Overview

Configuring Redundancy for PPPoE Subscribers

You must perform the following tasks to deploy the RBFS devices in redundancy mode. These configurations must be performed on both of the devices.

1. Set up the Redundancy Mode on the Platform Profile
2. Configure Redundancy Profile
3. Configure Session for Redundancy
4. Configure Link Aggregation Group for Redundancy

Configuration Syntax and Commands

The following sections describe syntax and commands for various configurations.

Configure the Redundancy Mode

You must select the standby-non-forwarding option under the platform profile.



This setup is a one-time activity and system reboot is required the changes to take effect.

To set the desired redundancy mode, use the command.

Syntax:

```
set system platform profile <profile-name> redundancy-mode standby-
```

non-forwarding

Attribute	Description
<profile-name>	Name of the platform profile.
standby-non-forwarding	Active-Standby Redundancy mode. Standby node and LAG does not forward traffic unless a failover occurs.

Example:

This configuration defines a platform profile named '4q' and enables 'standby-non-forwarding' mode.

```
set system platform profile 4q
set system platform profile 4q redundancy-mode standby-non-forwarding
```

```
supervisor@rtbrick.net: cfg> show config system platform profile
{
  "rtbrick-config:profile": [
    {
      "profile_name": "4q",
      "redundancy-mode": "standby-non-forwarding"
    }
  ]
}
```

Configuring Redundancy Profile

Redundancy profile is used to provide peer node identity in redundancy. While configuring the redundancy profile on the nodes, you need to specify IP addresses of both the peer nodes. Based on the priority value that you specify for the session ID, the peers take the roles of active and standby for the subscriber session.

Syntax:

set redundancy profile <name> **peer ipv4 instance** <instance>
set redundancy profile <name> **peer ipv4 remote-address** <remote-address>
set redundancy profile <name> **peer ipv4 update-source** <update-source>
set redundancy profile <name> **switchover-hold-timer** <0-600>

Attribute	Description
name	Name of the redundancy profile.
instance	Name of the instance.
remote-address	Specifies the IPv4 address of the peer BNG.
update-source	Specifies the source IPv4 address used by the local node.
switchover-hold-timer	Minimum interval time between consecutive switch-overs in seconds. Supported range: 0 - 600.

Example:

This configuration sets up a redundancy profile called 'rd_pppoe' and details the essential parameters for establishing peer connectivity. The remote-address specifies the peer BNG, the update-source designates the local address for the redundancy session, and the instance parameter defines the routing instance that manages the peer connection.

```
set redundancy profile rd_pppoe
set redundancy profile rd_pppoe peer ipv4 remote-address 198.51.100.2
set redundancy profile rd_pppoe peer ipv4 update-source 198.51.100.1
set redundancy profile rd_pppoe peer ipv4 instance default
```

```
supervisor@rtbrick.net: cfg> show config redundancy profile
{
    "rtbrick-config:profile": [
      {
        "name": "rd_pppoe",
        "peer": {
          "ipv4": {
            "remote-address": "198.51.100.2",
            "update-source": "198.51.100.1",
            "instance": "default"
          }
        }
      }
    ]
  }
```

API To access the RESTCONF API that corresponds to this CLI, click here.

Configuring Session for Redundancy

You can configure Redundancy session with a unique session ID. You can define

the system priority value (which determines active and standby roles) and the associate Redundancy profile configuration in the Redundancy Session configuration.

Syntax:

set redundancy session <id> **keepalive-interval** <value>
set redundancy session <id> **priority** <priority>
set redundancy session <id> **profile** <profile>

Attribute	Description
keepalive-interval	Keepalive message transmission interval in seconds. Supported range is 1 - 30. Default is 3 seconds.
id	Session ID supported value range is 1 - 255.
priority	The node with the higher priority value becomes the active node.
profile	Redundancy profile name.

Example for configuring session for redundancy.

The following configuration creates a redundancy session (session ID 100) and links it to the 'rd_pppoe' redundancy profile. The priority value determines the node's preference for acting as the active unit.

```
set redundancy session 100
set redundancy session 100 priority 10
set redundancy session 100 profile rd_pppoe
```

Configuration Example:

```
supervisor@rtbrick.net: cfg> show config redundancy session
{
    "rtbrick-config:session": [
      {
        "session-id": 100,
        "priority": 10,
        "profile": "rd_pppoe"
      }
    ]
  }
```

API To access the RESTCONF API that corresponds to this CLI, click here.

Configuring LAG for Redundancy

You must associate the Redundancy session ID with the LAG. While configuring LAG for redundancy, you must specify the session ID to associate the LAG with the Redundancy Session. LAG can identify its Redundancy session with this mapping.

For information on how to configure LAG for Redundancy, see Configuring LAG for Redundancy.

Switchover Manually

In the Active-Standby redundancy mode, administrators can perform a manual switchover from an active node to a standby node. Use the following command to perform switchover:

```
switch-over session <id> confirm
```

5.10.3. Redundancy for PPPoE Subscribers Operational Commands

Redundancy Show Commands

The Redundancy show commands provide detailed information about various redundancy operations.

Redundancy Details

The following show commands provides information about redundancy client daemons and redundancy sessions.

Syntax:

show redundancy <options>

Option	Description
client	Displays information about redundancy client daemons.
session	Displays session details.

Redundancy Client Statistics

This show command displays details about the client daemon participate in the redundancy.

Syntax:

show redundancy client <name> **statistics**

This command displays information from redundancy client (daemon) which is a participant in the redundancy sessions. The daemons ifmd and lagd are the client daemons participate in the redundancy sessions.

The following output displays the statistical information for LAGD.

```
supervisor@rtbrick.net: cfg> show redundancy client lagd statistics
Session id: 100, Profile: rd_ipoe_olt1
  Agent State: down
  TCP operational state: up
  Message statistics:
  Agent State: down
  TCP operational state: up
  Message statistics:
    Keepalive sent    : 0
    Keepalive received: 0
  Last 5 state changes: [Latest first]
    down                : 2026-01-06T11:54:27.797207+0000
    demote-ready        : 2026-01-06T11:54:27.797183+0000
    demote-infra-wait   : 2026-01-06T11:54:27.797163+0000
    demote-app-wait     : 2026-01-06T11:54:27.797130+0000
    active              : 2026-01-06T10:00:02.833306+0000
  Connection statistics:
    Peer Address: 192.1.0.200
    Application down notifications: 0
    Connection down notifications: 0
    Retry count: 0
    Session down received: 3
Session id: 200, Profile: rd_ipoe_olt2
  Agent State: down
  TCP operational state: up
  Message statistics:
    Keepalive sent    : 0
    Keepalive received: 0
```

```
  Last 5 state changes: [Latest first]
    down                : 2026-01-06T11:54:31.831395+0000
    demote-ready        : 2026-01-06T11:54:31.831373+0000
    demote-infra-wait   : 2026-01-06T11:54:31.831354+0000
    demote-app-wait     : 2026-01-06T11:54:31.831324+0000
    stand-alone         : 2026-01-06T11:54:27.988625+0000
  Connection statistics:
    Peer Address: 192.1.0.20
    Application down notifications: 0
    Connection down notifications: 0
    Retry count: 0
    Session down received: 3
```

Redundancy Session Details

These show commands provide information about redundancy sessions.

Syntax:

show redundancy session <id> <options>

Option	Description
-	Without any option, it displays all session details.
detail	Displays details session information.
history	Displays session history.
status	Displays session status.

Example output showing the status of a specified redundancy session ID.

```
supervisor@rtbrick.net: cfg> show redundancy session 100 status
State: down,  Remote State: down
Redundancy client replication information:
  Total redundancy clients : 4
  ifmd:
  ipoed.1:
  lagd:
  subscriberd.1:
    Number of subscribed table: 2
    Number of published table: 0
    Number of table subscription requested: 2
```

The following example output displays the detailed view of the specified redundancy session.

```
supervisor@rtbrick.net: cfg> show redundancy session 200 detail
Redundancy session ID: 200, Source: 192.1.0.10, Peer: 192.1.0.20
  Instance: default, Profile name: rd_ipoe_olt2, Local priority: 210
  State: down, Previous state: stand-alone, Last state transition time: 2026-01-
06T11:54:31.825860+0000
  Peer state: down
  Mode: standby-non-forwarding
  Interface: lag-11
  TCP operational state: up
  Message statistics:
    Keepalive sent       : 13248
    Keepalive received   : 13249
    Keepalive ignored    : 0
  Switchovers via cli    : 0
  State transition statistics:
    Down                 : 1
    Connect              : 1
    Standby              : 1
    Active               : 0
    Stand-alone          : 1
    Demote               : 0
  Timers:
    Connect retry interval              : 4294967295
    Keepalive timer interval            : 5000
    Holddown timer interval             : 20000
    Switchover timer pending interval   : 0 sec
  Timer Statistics:
    Holddown timer expiry count         : 0
```

The following example output displays the recent history entries for redundancy session 200, limited to 5 events

```
supervisor@rtbrick.net: cfg> show redundancy session 200 history count 5
Previous state       Current state        State change reason  Timestamp
stand-alone          down                 down                 2026-01-
06T11:54:31.825860+0000
standby              stand-alone          stand-alone          2026-01-
06T11:54:27.983076+0000
connect              standby              standby              2026-01-
06T10:00:02.627726+0000
down                 connect              open                 2026-01-
06T09:59:52.767142+0000
invalid              down                 init                 2026-01-
06T09:59:06.689775+0000
```

6. Forwarding

6.1. Interfaces

6.1.1. Interfaces Overview

RtBrick Full Stack (RBFS) supports various types of interfaces, including physical and logical interfaces. On hardware platforms, RBFS physical interfaces represent the ports of a switch. This guide describes how to configure and verify RBFS interfaces. Features like routing protocols or access services will typically run on top of the interfaces.

Interface Types

Physical Interfaces

In RBFS, physical interfaces (IFP) typically represent the physical ports of a hardware switch. For example, ifp-0/0/1 represents switch port 1. On the physical interface level, you can configure various parameters associated with Layer 1 of the ISO/OSI reference model.

Logical Interfaces

For each physical interface, you can create one or multiple interface units also referred to as logical interfaces (IFL) in RBFS. A logical interface is associated with the Layer 2 operation. In addition, you can configure Layer 3 parameters like IP addresses on interface units, and assign interface units to routing instances.

Loopback Interfaces

A loopback interface is typically used to represent and identify a device itself. Loopback interfaces are preferred because they do not depend on the status of a physical port, and will always be up. Please note, although loopback interfaces are virtual interfaces, there are also represented as physical interfaces and interface units in RBFS, reflecting Layer 1 and Layer 2/3 operation. Do not configure the broadcast IP address on the loopback interface.

Host Interfaces

Linux virtual ethernet (veth) interfaces connect an LXC container with the Linux host OS. In RBFS, a veth interface to the Linux bridge lxcbr0 is created by

default. In virtual topologies, you can create additional veth interfaces and Linux bridges. RBFS host interfaces represent veth interfaces in RBFS.
For example, if the container interface eth1 connects to the host interface vethXYZ123, ifp-0/0/1 can be bound to eth1 to represent it in RBFS. Host interfaces can be used like any other physical interface.

Memory Interfaces

Memory interfaces (memif) are virtual interfaces used for creating virtual topologies. They connect multiple containers running RBFS to each other. When configuring memif interfaces:

- Endpoints match on the memif ID, i.e. the memif ID needs to be the same on both ends.
- memif IDs need to be unique on the host.
- The memif interface name is locally significant only.
- One endpoint needs to be configured as a master, while the other one is configured as a slave.

Interface Numbering

RBFS interface numbers match the port numbers on the switch faceplate. An interface is named in the ifp-<chassis-ID>/<front-panel-block-number>/<port> format. For example, ifp-0/0/1.

- Chassis ID—always 0 for the currently supported platforms
- Front Panel Block—represents group of ports on the faceplate
- Port—matches the port number on switch faceplate

Virtual interfaces follow the same structure, for example, lo-0/0/1 or memif-0/0/1.

Logical interfaces are numbered: ifl-<Node ID>/<Chip ID>/<Port ID>/<Unit ID>, for example ifl-0/0/1/1.

Logical Interface Unit Limit

The supported logical interface (IFL) unit number is 16,000. It provides flexibility in naming logical interfaces across a variety of service configurations and is useful for deployments that require large numbers of logical interfaces, such as double-

tagged VLAN environments that combine Layer 2 and Layer 3 sub-interfaces.

Reverse Path Forwarding on Logical Layer-3 Interfaces

RBFS supports enabling Reverse Path Forwarding (RPF) in both strict and loose modes on logical Layer-3 IFLs. This feature ensures that packets received on IFLs can be validated against their expected reverse path. It improves security for deployments that rely on Layer 3 IFLs.

This feature is supported on all Q2C and Q2A-based RBFS platforms.

Community Support for Interfaces

You can tag an interface address with a community or extended community. RBFS will create a direct route for each interface address. If a community or extended community is configured for an interface address, RBFS will add it to the direct route. Communities can be used in policies. For example, when redistributing direct routes, you can match these communities and define desired policy rules.

Unnumbered Interfaces

An unnumbered interface is a point-to-point interface that is not explicitly configured with a dedicated IP address; instead, it borrows an IP address from a loopback interface.

For details about configuring an unnumbered interface, see section Logical Interface Configuration.

Unnumbered Interface to Numbered Interface (and Vice versa) Conversion

RBFS supports the conversion of unnumbered to numbered interface and vice versa in a single commit. The existing address should be deleted before converting the interface to an unnumbered interface. These two operations are supported in one commit.

Converting a numbered interface to an unnumbered interface

```
supervisor@rtbrick>: cfg> delete interface ifl-0/0/0 unit 11 address ipv4 192.0.2.1/24
supervisor@rtbrick>: cfg> set interface ifl-0/0/0 unit 10 unnumbered interface lo-0/0/0/0
supervisor@rtbrick>: cfg> commit
```

Converting an unnumbered interface to a numbered interface

```
supervisor@rtbrick>: cfg> del interface ifl-0/0/3 unit 10 unnumbered interface lo-0/0/0/0
supervisor@rtbrick>: cfg> set interface ifl-0/0/3 unit 10 address ipv4 192.0.2.1/24
supervisor@rtbrick>: cfg> commit
```

Interface Description Length

Interface descriptions support up to 1024 characters (previously 128). This applies to all regular IFP, Layer 3 IFL, Layer 2 IFL, LAG Layer 3 IFL, and LAG Layer 2 IFL interfaces.

Interface States

RBFS supports various interfaces such as physical interface, logical interface, and LAG interface and it uses various indicators to show the various states of interfaces. All interfaces have different states such as the following:

- Admin state: Indicates whether the interface is enabled (Up) or disabled (Down).
- Link state: Indicates whether the interface is linked (Up) or not linked (Down).
- Oper state: Indicates whether the interface is functional (operational) or not functional.
- IPv4 state: Indicates that the interface is configured with the IPv4 address.
- IPv6 state: Indicates that the interface is configured with the IPv6 address.
- MPLS state: Indicates that the interface is an MPLS-enabled interface.

Physical Interface States:

The physical interface states include:

- admin
- oper (operational)
- link

Logical Interface States:

The logical interface states include:

- admin
- oper (operational)
- link
- IPv4
- IPv6
- MPLS

LAG Interface States

The LAG interface states include:

- admin
- oper(operational)

The interface state can either be Up or Down. Up shows that it is ready to pass packets, and Down shows that it is not ready to transmit packets. The operational state shows that the interface is operational and is ready to transmit packets. The Oper state is Up only if both the Admin state and Link state are Up.

Auto-negotiation

Auto-negotiation allows directly connected devices to automatically exchange speed and duplex mode information for the links. If auto-negotiation is enabled, ports can auto-negotiate the speed and duplex capabilities with other ports. The auto-negotiation can determine the best speed and duplex at which the ports can operate optimally.



Port speed configuration and auto-negotiation are mutually exclusive.

RBFS supports auto-negotiation between ports in the following ways:

- 1G ports can negotiate with 10G ports.
- 40G ports can negotiate with 100G ports.

Auto-negotiation is not supported for the following combinations:

- 40G ports cannot negotiate with 1G ports, 10G ports, and 25G ports.

- 100G ports cannot negotiate with 1G ports, 10G ports and 25G ports.
- 1G port cannot negotiate with 25G port.

Interface Counters

Interface counters are statistics that network devices maintain for the traffic passing through the interfaces for all physical, logical, and LAG interfaces on a device. These counters provide information about the utilization and performance of the interface. Users can identify and troubleshoot issues such as congestion, errors, and performance bottlenecks by monitoring these counters.

RBFS Logical Interface counters and descriptions

Counters	Descriptions
Rx packets	The number of IP packets received by the logical interface.
Rx bytes	The number of bytes received by the logical interface.
Tx packets	The number of packets transmitted by the logical interface.
Tx bytes	The number of bytes transmitted by a logical interface.
IPv4 packets	The number of IPv4 packets processed by a logical interface.
IPv6 packets	The number of IPv6 packets processed by a logical interface.
MPLS packets	The number of MPLS packets processed by a logical interface.
Punt packets	The number of packets that are punted or forwarded to the CPU for further processing by a logical interface.
Drops packets	The number of packets that were dropped by a logical interface.
Rx Miss packets	The number of packets that were dropped by a logical interface.

Counters	Descriptions
Rx Error packets	The number of packets that were received with errors by the logical interface.
Rx No Buff packets	The number of packets that could not be received due to a lack of buffer space. When a logical interface receives a packet but does not have enough buffer space to store it, the packet is dropped.
Tx Error packets	The number of packets that could not be transmitted due to errors encountered during the transmission process.
Packet Statistics	
Ingress forwarded packets	The number of packets that are received by the device on one interface and then forwarded out on another interface.
Ingress forwarded bytes	The number of bytes that are received by a device on one interface and then forwarded out on another interface.
Ingress drop Packets	The number of packets that are dropped (discarded) by a network device upon arrival on one of its interfaces by a device.
Ingress drop bytes	Total number of bytes that have been dropped by an interface on incoming traffic.
Egress forwarded packets	Total number of packets that have been successfully forwarded by an interface on outgoing traffic.
Egress forwarded bytes	The number of bytes that have been forwarded by an interface in the egress direction.
Egress drop packets	The number of packets that have been dropped by an interface in the egress (outgoing) direction.
Egress drop bytes	The number of bytes that have been dropped by an interface in the egress direction.

RBFS physical interface counters and descriptions

Physical Interface Counters	Descriptions
VPP Statistics	
Rx packets	The number of IP packets received by the physical interface.
Rx bytes	The number of bytes received by the physical interface.
Tx packets	The number of packets transmitted by the physical interface.
Tx bytes	The number of bytes transmitted by the physical interface.
IPv4 packets	The number of IPv4 packets processed by the physical interface.
IPv6 packets	The number of IPv6 packets processed by the physical interface.
MPLS packets	The number of MPLS packets processed by a physical interface.
Punt packets	The number of packets that are punted or forwarded to the CPU for further processing by a physical interface.
Drops packets	The number of packets that were dropped by a physical interface.
Rx Miss packets	The number of packets that were dropped by a physical interface.
Rx Error packets	The number of packets that were received with errors by the physical interface.
Rx No Buff packets	The number of packets that could not be received due to a lack of buffer space. When a physical interface receives a packet but does not have enough buffer space to store it, the packet is dropped.
Tx Error packets	The number of packets that were dropped by a physical interface.
BCM Statistics	

Physical Interface Counters	Descriptions
inOctets	Number of octets received through the interface.
inUcastPkts	Number of unicast packets received through the interface.
inNonUcastPkts	Number of non-unicast packets received through the interface.
inErrors	The number of inbound packets that contained errors preventing them from being processed correctly.
outOctets	Number of octets sent through the interface.
ifHCInOctets	The number of octets (8-bit bytes) received by a network interface. It is a part of the SNMP MIB (Management Information Base) structure and is used to track high-capacity input octets counter used in the context of SNMP monitoring.
outUcastPkts	Number of unicast packets sent through the interface.
outNonUcastPkts	Number of non-unicast packets sent through the interface.
outErrors	The number of outbound packets that contained errors preventing them from being processed correctly.
etherStatsDropEvents	Number of events where packets were not delivered to the protocol stack because of resource limitations or other reasons. These dropped events can occur due to buffer overflows, congestion, or hardware limitations.
etherStatsMulticastPkts	The number of packets received by an interface that were addressed to a multicast MAC address.
etherStatsBroadcastPkts	The number of broadcast packets received on an Ethernet interface.
etherStatsUndersizePkts	The number of received packets that are smaller than the minimum allowed Ethernet frame size. Undersized packets can indicate various issues.

Physical Interface Counters	Descriptions
etherStatsFragments	The number of received packets that are fragments of IP datagrams.
etherStatsOversizePkts	The number of received packets that exceed the maximum Ethernet frame size.
etherStatsOctets	The total number of octets (bytes) of data transmitted and received on an Ethernet interface. This counter provides a measure of the total amount of data traffic on the interface.
etherStatsPkts	The number of packets transmitted or received by an Ethernet interface. This counter can provide insights into the traffic load and performance of the interface.
dot1dBasePortMtuExceedDiscards	The number of frames that were discarded at an interface as they exceeded the Maximum Transmission Unit (MTU) of the port. This typically happens when a frame is larger than the maximum size allowed on the interface and cannot be fragmented, so it is dropped.
etherStatsTXNoErrors	The number of Ethernet frames transmitted without any errors through the Ethernet interface. Each time a frame is successfully transmitted without encountering any errors, this counter is incremented.
etherStatsRXNoErrors	The number of Ethernet frames received without any errors through the Ethernet interface. Each time a frame is successfully transmitted without encountering any errors, this counter is incremented.
inMulticastPkts	The number of packets received by the interface that were addressed to a multicast address. These counters provide insights into the amount of multicast traffic being received by the interface.
outBroadcastPkts	The number of packets transmitted by the network interface as broadcast packets. These counters can provide insights into the amount of broadcast traffic generated by the interface.

Physical Interface Counters	Descriptions
outMulticastPkts	The number of packets transmitted by the interface as multicast packets. These counters can provide insights into the amount of multicast traffic generated by the interface.
outBroadcastPkts	The number of packets transmitted by the interface as broadcast packets. These counters can provide insights into the amount of broadcast traffic generated by the interface, which can be useful for network troubleshooting and monitoring network performance.
bcmReceivedUndersizePkts	The number of undersized packets received by a Broadcom device. Undersized packets are Ethernet frames that are smaller than the minimum allowed size. This counter provides insights into packet size issues.
bcmTransmittedUndersizePkts	The number of undersized packets sent by a Broadcom device. Undersized packets are Ethernet frames that are smaller than the minimum allowed size. This counter provides insights into packet size issues.
etherTxOversizePkts	The number of packets that exceed the maximum transmission unit (MTU) size allowed on an Ethernet interface.
etherStatsJabbers	The number of jabber frames received by an Ethernet interface. Jabber frames are Ethernet frames that exceed the maximum allowed frame size and contain data that extends beyond the maximum length.

Physical Interface Counters	Descriptions
etherStatsCRCAlignErrors	The number of frames received by an Ethernet interface that has a CRC (Cyclic Redundancy Check) error. Also, the frames are not an integral number of octets in length; that is, the frame length is not a multiple of 8 bits. CRC errors occur when the CRC checksum calculated by the receiving interface does not match the CRC checksum transmitted by the sending interface, indicating that the frame may have been corrupted during transmission
dot3StatsFCSErrors	The number of frames that have a Frame Check Sequence (FCS) error received by an Ethernet interface. The FCS is a field in the Ethernet frame that contains a checksum calculated based on the contents of the frame.
ifHCOutMulticastPkts	The number of outbound multicast packets on a network interface. The ifHCOutMulticastPkts object uses a 64-bit counter, allowing it to accommodate high-speed interfaces without wrapping around as quickly. It provides an accurate count of the outbound multicast packets on the interface.
ifHCOutBroadcastPckts	The ifHCOutBroadcastPkts counter provides the number of outbound broadcast packets on an interface. It is part of the IF-MIB (Interface MIB) and is an extension of the standard ifOutBroadcastPkts counter, providing a 64-bit counter for high-speed interfaces to avoid wrapping around quickly.

Permanent ARP Entry on IFLs

The Permanent ARP Entry functionality is supported on IFLs. This functionality enables devices to proactively resolve ARP and ND.

Path MTU Discovery

Path MTU Discovery (PMTUD) is a technique that is used to determine the Maximum Transmission Unit (MTU) size that can be used along the path from a source to a destination without requiring fragmentation. PMTUD helps to avoid fragmentation by dynamically discovering the smallest MTU in the path.

PMTUD is crucial for optimizing network performance by avoiding fragmentation.

By default, path MTU discovery is enabled in RBFS.

When RBFS receives packets that violate the MTU, meaning their size exceeds the allowed MTU size, it will respond with the following ICMP error message:

ICMPv4 Message Types

The type field specifies the message type sent by the host, providing detailed information about the error condition.

The following tables show the ICMPv4 message types.

Type	Description
3	Destination Unreachable. This message notifies the source host about delivery issues faced while attempting to reach the destination.

Destination Unreachable uses the following code values to further describe the function of the ICMP message being sent.

Code	Description
4	Fragmentation Needed and Don’t-Fragment (DF) was Set. This message shows when a router receives a packet that requires fragmentation while having the DF flag enabled.

ICMPv6 Message Types

The type field identifies the type of the message sent by the host. The type field contains more specific information about the error condition.

The table below lists the ICMPv6 message type.

Type	Description
2	Packet Too Big. A Packet Too Big must be sent by a router when it receives a packet that cannot be forwarded because it is larger than the MTU of the outgoing link.

Code	Description
0	No code

You can modify this behavior by enabling fragmentation. For details on how to enable hostpath fragmentation, refer to the section 'Enabling Hostpath Fragmentation' below.

All outgoing packets are validated against the configured MTU on the egress path.

- If MTU is violated and MTU-profile action is drop, then packets are dropped in hardware.
- If MTU is violated and MTU-profile action is redirect-to-cpu, a 20MB policer is used to protect the CPU-port from overwhelming MTU-violated traffic, and packets are sent to the CPU port.
- When fragmentation is enabled, one of the following operations takes place.

  If the DF (Don't Fragment) bit is not set in the received packet (applicable only to IPv4), the packets are fragmented and sent to the outgoing port.

  If the DF bit is set in a packet, it drops the packet and sends an ICMP error message back to the source host.
- If the fragmentation is disabled, packets are dropped and ICMP error messages are sent to the source host.

For information on configuring the MTU profile, see MTU Profile Configuration.

IP Fragmentation

If the size of the original IP packet exceeds the MTU of the outgoing interface, the packet must be fragmented.



RBFS supports IP fragmentation on its Q2C platforms.

The MTU profile configuration determines if packets exceeding the MTU are

dropped or sent to the CPU for further processing.

The forwarding-options configuration includes a setting to enable hostpath fragmentation for packets redirected to the CPU. If this setting is not configured, the device responds with an ICMP error message to the source host.



MTU fragmentation is not supported on core interfaces configured as LAG. You must disable the re-injection for MTU fragmentation to function on LAG interfaces nn Q2C platforms.

Guidelines and Limitations of IP Fragmentation

The following guidelines and limitations apply to IP Fragmentation:

- If a packet exceeds the negotiated subscriber MTU size, the packet is either dropped or fragmented based on the configured MTU profile (applicable only to on the Q2C platforms). The host-path fragmentation is not supported; only an ICMP error message is sent to the source host. For information on MTU profile configuration, see section "MTU Profile Configuration".

You can control fragmentation behavior using the set forwarding-options fragmentation ipv4 state CPU command. For more information about configuring fragmentation, see Enabling Hostpath Fragmentation. * Fragmented packets are reinjected into the egress pipeline and forwarded through the regular QoS path.

- No ICMP error messages are generated for MTU-violated multicast packets.

MTU Profile

The Maximum Transmission Unit (MTU) defines the largest packet size that is allowed to transmit across the network.

In the Q2C Platforms, resource efficiency is achieved by using MTU profiles. Components such as IFPs, IFLs, and L3 interfaces reference these MTU profiles. To optimize MTU resource management, you can configure MTU profiles, which can then be applied to various attachment points. The MTU profiles are attached to the physical (IFP), logical (IFL) and L3 interfaces. RBFS supports the following attachment points for MTU profiles.

Attachment Points: The MTU profiles are attached to the interface entities such as physical (IFP), logical (IFL) and L3 interfaces. RBFS supports the following

attachment points for MTU profiles:

- Port-level
- L3 interface level (IPv4 and IPv6)
- PPPoE subscriber level (L2 IFL)
- IPoE subscriber level

MTU Size: A user-configured MTU size can range from 64 to 9216 in RBFS.



For MTU profiles of type 'pppoe', users should provide L3 MTU size (IPv4/IPv6 headers).

MTU Type: An MTU type specifies the attachment point of the MTU profile. The MTU types supported are as follows:

- **physical**: When checking the MTU, the total size of the packet, including headers, is considered.
- **ipv4**: The MTU check is conducted based on IPv4 headers.
- **ipv6**: The MTU check is conducted based on IPv6 headers.
- **ip**: MTU profile of type IP and IPoE.
- **pppoe**: The MTU profile is applied to the PPPoE subscriber interface, where you must specify the L3 MTU size. Using its best-match algorithm, the subscriber management service associates these profiles with PPPoE subscribers.



- MTU profiles for Layer 3 logical interfaces must be explicitly configured. If not set, no default MTU size is applied for either IPv4 or IPv6 traffic.
- On the Q2C platform, L3 interfaces can be configured with either an IPv4 MTU profile or an IPv6 MTU profile, but not both. However, by using an MTU profile of type 'ip', you can set a common MTU size that applies to both IPv4 and IPv6 traffic.
- On the QAX platform, only physical MTU profiles are supported.

MTU Action:

The MTU action specifies the response when an MTU check fails. The following actions are supported:

- drop: This indicates that when the MTU check fails, the action "drop" is performed.
- redirect-to-cpu: This is an action of redirecting packets to the CPU in a traffic behavior. The redirect-to-cpu action must be configured for the fragmentation to work.

MTU Profile Limitations

The MTU profile has the following limitations.

- The MTU violation trap is signalled at the ETTP stage (Egress) of the pipeline. Therefore, it is expected that the bandwidth consumed by dropped packets due to MTU violations will be accounted for.
- Each hardware unit supports a limited number of MTUs. Therefore, the following limits apply.
- **MTU Profile Limits by Platform:**

  Q2C Platform:

  Total MTU profiles supported: 8

  L3 MTU profiles (IP/IPv4/IPv6): Up to 3

  PPPoE MTU profiles: Up to 6 (including the default PPPoE profile)

  Physical MTU profiles: Up to 7

  QAX Platform:

  Physical MTU profiles: 1 only

Interface Holddown

Overview

Interface Holddown or Interface Dampening is a delay mechanism to prevent network instability from flapping interfaces. Interface flapping occurs when an interface goes up and down repeatedly, leading to excessive route recalculations and needless notifications to other software components.

The Interface Holddown feature is used to prevent network instability by

temporarily damping the interface state if it is fluctuating. This mechanism suppresses frequently fluctuating routes and ensures that only stable routes are advertised. It improves overall network performance by effectively utilizing resources such as memory and processing power.



The Interface Holddown feature remains supported when interfaces are grouped in a LAG.

Option to Disable

By default, the Interface Holddown feature is enabled on RBFS. You can configure the ‘hold-down down delay’ and ‘hold-down up delay’ parameter values using the configuration commands. You can also disable the feature using the command.

Benefits of Interface Holddown

Frequent updates due to route flaps can consume significant processing capacity. This can increase the CPU load on routers, and the constant route advertisements and withdrawals can consume bandwidth. The Interface Holddown mechanism minimizes unnecessary route recalculations and notifications, and the number of updates that need to be processed by suppressing frequently flapping routes. Suppressing unstable routes can improve overall network performance by ensuring that only stable routes are advertised and used for forwarding traffic.

How RBFS Interface Holddown Works

When an interface flaps, such as an interface goes up and down frequently, RBFS employs a holddown period during which the interface’s status is retained in its previous state.

The holddown time for an interface increases exponentially within a defined range. The values can be configured explicitly for each interface. When an interface flap occurs, the interface management daemon receives this event from the hardware through the FIBD.

The following diagram shows the interface holddown feature.

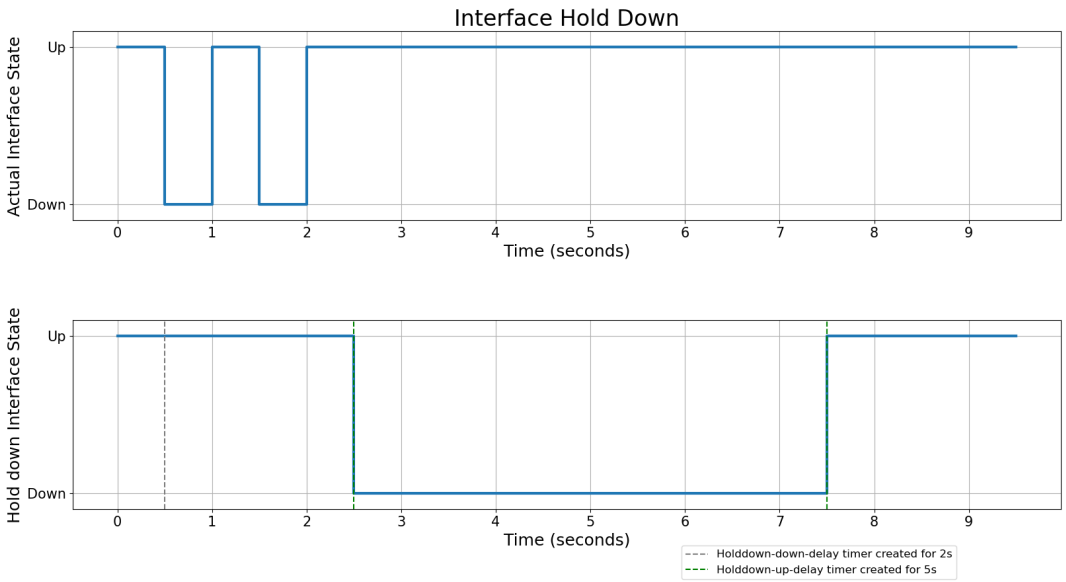


Figure 109. Interface Holddown

The holddown intervals are set at 0ms, 100ms, 200ms, 500ms, 1s, 2s, 5s, and 10s. When the holddown timer expires, the interface state is propagated to higher layers. If the interface remains stable throughout the holddown interval, the actual state is propagated. However, if the interface experiences instability during this interval, it remains in the DOWN state.

RBFS implements "Holddown Down Delay" and "Holddown Up Delay", two parameters that control how the interface flap is managed.

Holddown Down Delay

The ‘Hold-down Down Delay’ parameter, once configured, ensures that the interface state change from UP to DOWN is delayed by the specified ‘holddown down delay’ period. After this delay, the default holddown mechanism takes over. Specifically:

1. The ‘holddown’ interval starts with its initial value, that is 'holddown down delay' period, and increments exponentially when each timer expires.
2. DOWN to UP state changes are delayed based on exponentially increasing intervals.

The following diagram shows 'holddown down delay' scenario.

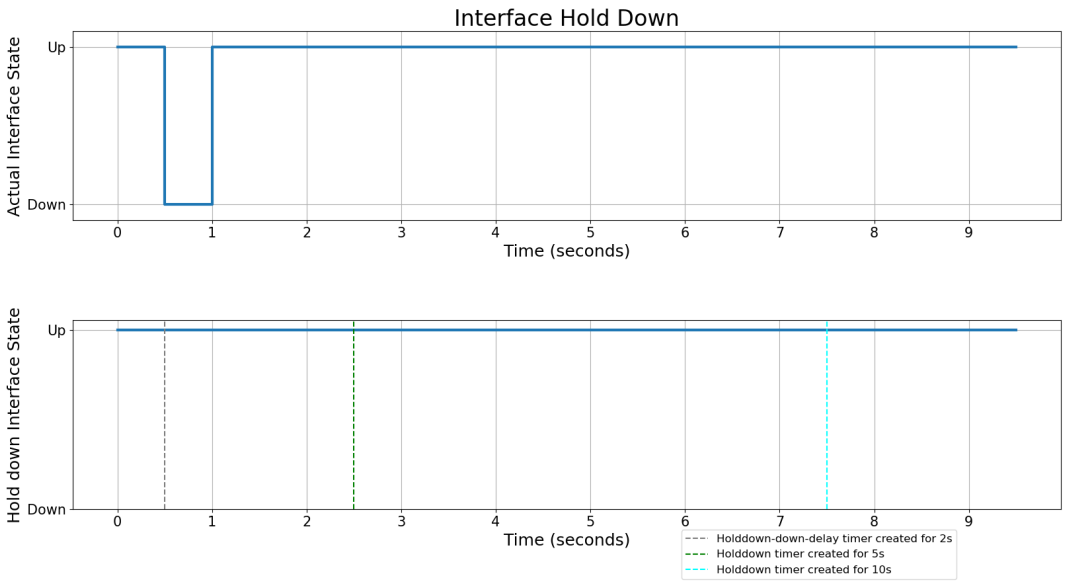


Figure 110. Interface Holddown Delay

For example, if the ‘holddown down delay’ is set to 5 seconds and the interface state changes from UP to DOWN, the interface remains up for 5 seconds. After this 5-second delay, the system checks the stability of the interface:

- If the interface has no flap during this period, it remains up.
- If the interface has flapped during this period, it changes to the DOWN state after the delay.

In summary, Holddown Down Delay ensures an interface remains up for a specified time before propagating any state change to higher-level software components.

Holddown Up Delay

'Holddown Up Delay' is the period that an interface stays down after a failure before it is considered to be in a stable state. When the state changes from DOWN to UP, a holddown timer is initiated with a specified delay period. If there are flaps during the previous interval time, then a new timer with the same 'holddown up' delay is set.

This results in a delay in the state transitioning to UP based on the ‘holddown up delay’. However, if state changes happen within the 'holddown up delay' interval, any change from UP to DOWN is immediately transmitted. It uses a static timer instead of an exponential backoff for the holddown interval.

NOTE:

If the holddown-up delay of 10,000 ms is explicitly configured by the user, the system will delay the link's status change by a fixed value of 10,000 ms. For example, if the link goes down and later becomes up, the system will declare the link as 'up' only after the delay of 10,000 ms.

If the holddown-up delay of 10,000 ms is not explicitly configured by the user, the default setting will show a value of 10,000 ms in the interface details. This default value represents the maximum duration that the system checks for link stability before declaring it as 'up'. In this case, if the link goes down and later returns, the system may declare the link as up immediately if the link is stable. However, if the link is not stable, the holddown time for the interface will increase exponentially within the range of 10,000 ms before it finally declares the link as 'up'.

The following diagram shows 'holddown up' scenario.

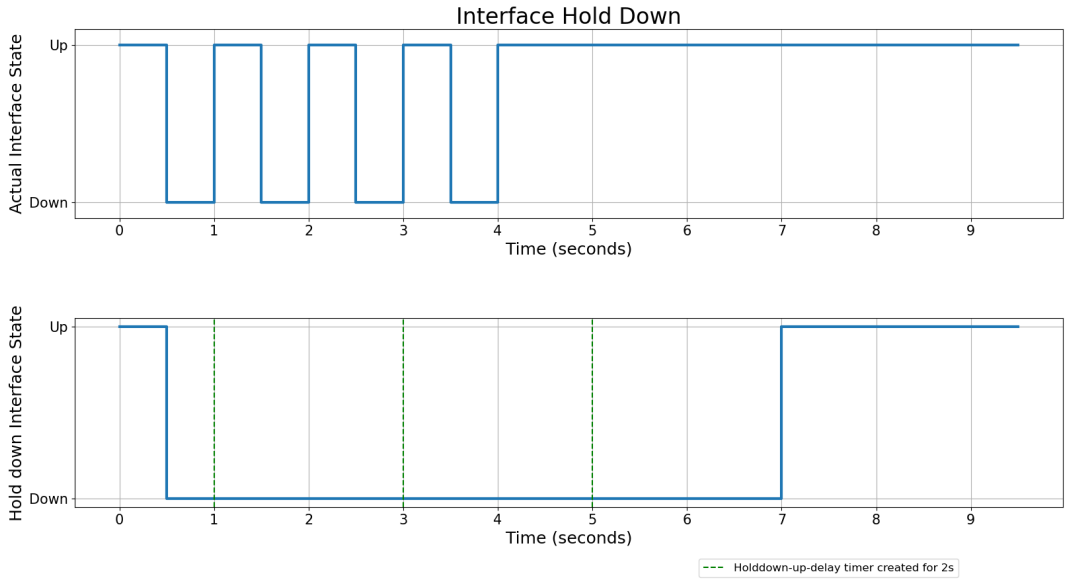


Figure 111. Interface Holddown Up Scenario

Example Scenario

Imagine where a router's interface occasionally loses and regains connectivity due to a loose cable. Each time this happens, it creates an event that propagates through many of the software components in the network.

Without the Interface Holddown feature, every time disruption immediately triggers network protocols and higher-level software components to respond, potentially causing routing updates, recalculations, and additional processing overhead. This constant back and forth leads to network instability and adds additional strain on network devices.

With the interface Holddown enabled, the RBFS still receives these flap events but employs a hold-down mechanism to delay taking action on these changes. For example, with the holddown intervals: 0ms, 100ms, 200ms, 500ms, 1s, 2s, 5s, and 10s, the system performs the following:

- Retain the old interface status when an interface flap is detected.
- Wait for the initial hold-down time, which is 100ms.
- If another transition occurs within this period, the hold-down time increases to the next interval that is, 200ms. This process repeats, increasing the hold-down time after each transition up to the configured maximum value, which is 10s.

In this way, by delaying the processing of interface flaps, interface dampening reduces the impact of flapping on the network. The system only updates the interface status after a stable period without transitions, thus preventing frequent, unnecessary updates.

IPv6 Link-Local Address

In IPv6 networking, link-local addresses are essential for local communication between nodes on the same link. It facilitates communication between nodes on the same link, however cannot be used to send packets beyond that link.

In RBFS, a link-local IPv6 address can be either automatically generated or manually assigned.

When a configured link-local address is deleted, a unique link-local address is automatically generated for the logical interface. This automatically assigned address is typically derived from the interface’s MAC address and other parameters.

You can also modify an existing automatically generated link-local address by manually configuring a link-local IPv6 address on a logical interface. It will replace the auto-generated link-local address with the one you have configured.

Guidelines & Limitations

QAX-based Platforms

An additional restriction applies to ports on QAX-based platforms: because of hardware design, physical ports are grouped into quads (groups of 4, also known as port groups). Each quad must have the same physical parameters: speed, link-training, duplex.

The following tables are provided for easy identification of ports that need to have the same physical settings:

Edgecore 7316-26XB Port Groups:

Port	Speed	Duplex	Port Group
ifp-0/0/0	100G	Full	0
ifp-0/0/1	100G	Full	1
ifp-0/1/0	10G	Full	2
ifp-0/1/1	10G	Full	
ifp-0/1/2	10G	Full	
ifp-0/1/3	10G	Full	
ifp-0/1/4	10G	Full	3
ifp-0/1/5	10G	Full	
ifp-0/1/6	10G	Full	
ifp-0/1/7	10G	Full	
ifp-0/1/8	10G	Full	4
ifp-0/1/9	10G	Full	
ifp-0/1/10	10G	Full	
ifp-0/1/11	10G	Full	

Port	Speed	Duplex	Port Group
ifp-0/1/12	10G	Full	5
ifp-0/1/13	10G	Full	
ifp-0/1/14	10G	Full	
ifp-0/1/15	10G	Full	
ifp-0/1/16	25G	Full	6
ifp-0/1/17	25G	Full	
ifp-0/1/18	25G	Full	
ifp-0/1/19	25G	Full	
ifp-0/1/20	25G	Full	7
ifp-0/1/21	25G	Full	
ifp-0/1/22	25G	Full	
ifp-0/1/23	25G	Full	

UfiSpace S9500-22XST Port Groups:

Port	Speed	Duplex	Port Group
ifp-0/0/0	10G	Full	8
ifp-0/0/1	10G	Full	
ifp-0/0/2	10G	Full	
ifp-0/0/3	10G	Full	
ifp-0/0/4	10G	Full	4
ifp-0/0/5	10G	Full	
ifp-0/0/6	10G	Full	
ifp-0/0/7	10G	Full	
ifp-0/0/8	10G	Full	11
ifp-0/0/9	10G	Full	
ifp-0/0/10	10G	Full	
ifp-0/0/11	10G	Full	

Port	Speed	Duplex	Port Group
ifp-0/0/12	25G	Full	3
ifp-0/0/13	25G	Full	
ifp-0/0/14	25G	Full	
ifp-0/0/15	25G	Full	
ifp-0/0/16	25G	Full	2
ifp-0/0/17	25G	Full	
ifp-0/0/18	25G	Full	
ifp-0/0/19	25G	Full	
ifp-0/0/20	100G	Full	0
ifp-0/0/21	100G	Full	1

A PHY Quad can be associated with network interface (NIF) ports of identical type only. For example, a quad cannot be a mix of XLGE and XE ports. An exception is GE and XE ports which can coexist in the same quad. This means all the ports in a port group should have the same physical interface configuration (that is, speed/duplex/link-training). Ports in a port group are only allowed to support 1G and 10G speeds; any other combination is not allowed. If a port within a port group is misconfigured, then it would require changing the speeds/interface type of all ports within the port group to a different type and then back into the original type.

Support for TTL Inheritance from IP to MPLS

RBFS support for inheriting the IP TTL into the MPLS TTL at the ingress node by enabling TTL propagation. It ensures traceroute visibility across the MPLS network.



By default, the IP TTL is not inherited at the MPLS ingress node and the MPLS TTL is set to the value '64'.

Supported Platforms

Not all features are necessarily supported on each hardware platform. Refer to the Platform Guide for the features and the sub-features that are or are not supported by each platform.

6.1.2. Interfaces Configuration

Configuration Hierarchy

The diagram illustrates the interface configuration hierarchy.

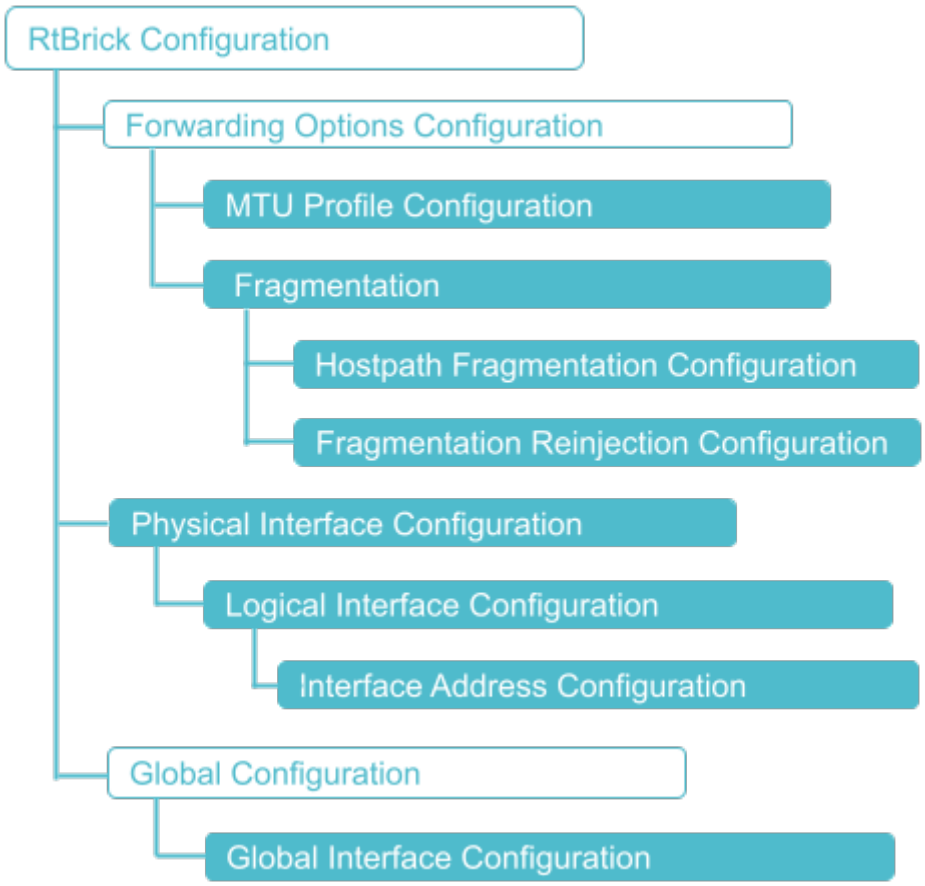


Figure 112. Interface Configuration Hierarchy

Configuration Syntax and Commands

The following sections describe the interface configuration syntax and commands.

MTU Profile Configuration

This section describes how to configure MTU profiles.

Syntax:

set forwarding-options mtu-profile <attribute> <value>

Attribute	Description
mtu-profile <mtu-profile-name>	MTU profile name
mtu-size <mtu-size>	MTU size. Range: 64 to 9216 bytes
mtu-type <mtu-type>	Specify the MTU type: • **physical**: Port based MTU profile • **pppoe**: subscriber IFL-based MTU profile for L2TP and PPPoE. This MTU profile is used by PPPoE subscribers to set the default MTU size of 1492. A configured size of 1492 bytes limits the size of the IPv4 or IPv6 header plus payload. • **ipv4**: MTU profile of type IPv4. Only IPv4 traffic on the logical interface will be impacted. • **ipv6**: MTU profile of type IPv6. Only IPv6 traffic on the logical interface will be impacted. • **ip**: MTU profile of type IP. Both IPv4 and IPv6 traffic on the logical interface will be impacted.
action <mtu-action>	Specify the MTU action. The following options are supported: **drop**: This indicates that when the MTU check fails, the action "drop" is performed. **redirect-to-cpu**: This is an action of redirecting packets to the CPU in a traffic behavior. A redirect-to-cpu action must be configured for fragmentation to occur.

Example 1: Configuration of the MTU Profile for the Physical Port

```
{
  "ietf-restconf:data": {
    "rtbrick-config:forwarding-options": {
      "mtu-profile": [
        {
          "mtu-profile-name": "portMtu",
          "size": 5000,
          "type": "physical",
          "action": "redirect-to-cpu"
        }
      ]
```

```
    }
  }
}
```

Example 2: MTU Profile Configuration of Type IPv4

```
{
  "ietf-restconf:data": {
    "rtbrick-config:forwarding-options": {
      "mtu-profile": [
        {
          "mtu-profile-name": "ipv4Mtu",
          "size": 1300,
          "type": "ipv4",
          "action": "redirect-to-cpu"
        }
      ]
    }
  }
}
```

Example 3: MTU Profile Configuration of Type IPv6

```
{
  "ietf-restconf:data": {
    "rtbrick-config:forwarding-options": {
      "mtu-profile": [
        {
          "mtu-profile-name": "ipv6Mtu",
          "size": 1400,
          "type": "ipv6",
          "action": "redirect-to-cpu"
        }
      ]
    }
  }
}
```

Example 4: Configuration of the MTU Profile for PPPoE

```
{
  "ietf-restconf:data": {
    "rtbrick-config:forwarding-options": {
      "mtu-profile": [
        {
          "mtu-profile-name": "pppoeMtu",
          "size": 1492,
          "type": "pppoe",
          "action": "redirect-to-cpu"
        }
      ]
    }
  }
```

```
}
```

API To access the RESTCONF API that corresponds to this CLI, click here.

Enabling Hostpath Fragmentation

This section describes how to enable or disable fragmentation by CPU. It is necessary to configure MTU profile action "redirect-to-cpu" so that fragmentation takes place. By default, fragmentation is disabled.

Syntax:

set forwarding-options fragmentation ipv4 state <value>

Attribute	Description
disabled | cpu	Enables fragmentation of IPv4 packets. There are two options: disabled—Fragmentation is disabled. It is the default setting. cpu—Fragmentation is performed by CPU.

Example: Configuration of Hostpath Fragmentation

```
{
  "ietf-restconf:data": {
    "rtbrick-config:forwarding-options": {
      "fragmentation": {
        "ipv4": {
          "state": "cpu"
        }
      }
    }
  }
}
```

API To access the RESTCONF API that corresponds to this CLI, click here.

Configuring Policer Limits for Fragmented Traffic

RBFS optimizes performance for fragmented traffic by adjusting the default policer limits on the host path. Fragmentation packets received on the host path has a cap upto 150 Mbps, which enables higher throughput for fragmented traffic

Syntax:

set forwarding-options fragmentation ipv4 state <value>

set forwarding-options fragmentation ipv4 policer <policer-name>

The following policer configuration sets the RBFS host path to support 120 Mbps.

```
supervisor@rtbrick>SPINE01: cfg> set forwarding-options fragmentation ipv4 state
cpu
supervisor@rtbrick>SPINE01: cfg> set forwarding-options fragmentation ipv4 policer
policer_120MB
```

Example:

```
supervisor@rtbrick>: cfg> show config forwarding-options fragmentation
{
  "rtbrick-config:fragmentation": {
    "ipv4": {
    "state": "cpu",
    "policer": "policer_120MB"
    }
  }
}
```



- RBFS supports default policers, which can be applied to fragmentation traffic through the policer configuration.
- In addition to the default policer, users can define a custom policer and attach it to the fragmentation configuration. However, the committed information rate (CIR) cannot exceed 150Mbps.

Physical Interface Configuration

This section describes configuration options at the physical interface (IFP) level.

Syntax:

set interface <interface-name> <attribute> <value>

Attribute	Description
<interface-name>	Name of the interface. Example: ifp-0/0/1.
admin-status <down|up>	Administrative state of the interface.
auto-negotiation true	Enable auto-negotiation. To disable auto-negotiation, use the delete form of the command. NOTE: Port speed configuration and auto-negotiation are mutually exclusive.
holddown <disable|enable>	Enable or disable the holddown timer feature. By default, the feature is enabled.
holddown-down-delay <...>	Configure the down delay time in milliseconds (ms). Default range 0 - 10000 ms.
holddown-up-delay <...>	Configure the down delay time in milliseconds (ms). Default range 0 - 10000 ms.
class-of-service <profile-name>	Apply class-of-service profile name.
description	Configure physical interface description. Maximum 1024 characters.
host-if <container-interface>	Configure a host interface. For example, if the container interface eth1 connects to the host interface vethXYZ123, use this command option to bound hostif-0/0/1 to eth1.  The Linux virtual ethernet (veth) interface needs to be created separately. It cannot be created via RBFS configuration.

Attribute	Description
forward-error-correction <fec-type>	Configure Forward Error Correction (FEC) on the physical interface. FEC allows you to send the required information to correct errors through the link along with the payload data. A benefit of "forward" in FEC is that errors detected at the receiver do not need to be retransmitted. Currently, the supported FEC types are: base-r, rsfec, none. NOTE: rsfec is the only FEC supported for 100G on the QAX platform.
link-training true	Enable link training. To disable link training, use the delete form of the command.
master <true|false>	Memif role, master or slave, applicable only to memif interface. One end needs to be configured as master, and the other one as slave.
memif-id <id>	Configure memif ID, applicable only to memif interface. Needs to match on both ends.
mtu-profile <mtu-profile-name>	Attach MTU profile to a physical interface. This is a mandatory attribute.
mru <size>	Maximum receive unit size on the physical interface.
forward-error-correction-bypass <disable | enable>	When specify 'enable', the interface operates without applying FEC and reduces the processing latency. When disabled, the interface uses standard FEC operation as defined.

Attribute	Description
speed <speed>	Configure speed mode for the interface. Port speed refers to the maximum amount of data transmitted. The speed value is specified in Gigabits per second (Gbps). Currently, RBFS supports 10G and 100G ports, and you can make the following changes: • 100G port speed can be changed to 40G • 10G port speed can be changed to 1G

Example 1: Physical Interface Configuration

```
{
    "rtbrick-config:interface": [
      {
        "name": "ifp-0/0/1",
        "description": "Link to leaf1",
        "speed": "10G",
        "mtu-profile": "portMtu",
        "mru": 5000
      }
    ]
}
```

Example 2: Memory Interface Configuration

A End:

```
{
    "rtbrick-config:interface": [
      {
        "name": "ifp-0/0/1",
        "description": "Master",
        "memif-id": 11,
        "master": "true",
      }
    ]
}
```

B End:

```
{
    "rtbrick-config:interface": [
      {
        "name": "ifp-0/0/1",
```

```
        "description": "Slave",
        "memif-id": 11,
        "master": "false",
      }
    ]
  }
```

Example 3: Host Interface Configuration

```
{
    "rtbrick-config:interface": [
        "name": "ifp-0/0/1",
        "description": "Represents eth1 as ifp-0/0/1 in RBFS",
        "host-if": "eth1",
    ]
}
```

Example 4: MRU Configuration for Physical Interface

```
{
    "rtbrick-config:interface": [
      {
        "name": "ifp-0/0/7",
        "mru": 5000
      }
    ]
  }
```

Example 5: FEC Configuration for Physical Interface

```
{
    "rtbrick-config:interface": [
      {
        "name": "ifp-0/0/40",
        "forward-error-correction": "base-r"
      }
    ]
  }
```

API To access the RESTCONF API that corresponds to this CLI, click here.

API To access the Operational State API that corresponds to this CLI, click here.

Logical Interface Configuration

This section describes configuration options at the logical interface (IFL) level.

Syntax:

set interface <interface-name> **unit** <unit-id> <attribute> <value>

Attribute	Description
unit <unit-id>	Create a logical interface (also referred to as a sub-interface) under the physical interface.
address	Configure IPv4 and IPv6 address for sub-interface.
address-translation	Configure NAT for logical interface.
admin-status <down|up>	Administrative state of the logical interface.
class-of-service <profile-name>	Apply class-of-service profile name.
description <description>	Description of the logical interface. Maximum 1024 characters.
esi	Configure Ethernet Segment Identifier for L2 interface.
garp-disable true	Disables Gratuitous ARP (GARP). Default is GARP enabled.
inner-vlan <inner-vlan-id>	Inner VLAN ID.
input-vlan-map	Configure input VLAN mapping
input-vlan-map inner-vlan-id <inner-vlan-id>	Configure the inner VLAN for the VLAN operation specified
input-vlan-map vlan-encapsulation <802.1ad | 802.1q>	VLAN encapsulation at ingress
input-vlan-map vlan-id <vlan-id>	Configure the vlan for the vlan operation specified
input-vlan-map vlan-operation <push | pop | swap | push-push | pop-pop | swap-swap | swap-push | pop-swap>	VLAN operation at ingress
instance <instance>	Assign the logical interface to an instance.
interface-type	Configure L2 interface type

Attribute	Description
ip-mtu-profile <ip-mtu-profile>	Attach IP MTU profile to an L3 interface.
ipv4-admin-status <down|up>	Enable or disable IPv4.
ipv4-mtu-profile <ipv4-mtu-profile>	Attach IPv4 MTU profile to an L3 interface.
ipv6-admin-status <down|up>	Enable or disable IPv6.
ipv6-mtu-profile <ipv6-mtu-profile>	Attach IPv6 MTU profile to an L3 interface.
ip-mtu-profile <ip-mtu-profile>	Attach IP MTU profile to an L3 interface.
mpls-admin-status <down | up>	Enable or disable MPLS.
mpls-mtu <mpls-mtu-size>	MPLS maximum transmission unit size.
neighbor <ipv4 | ipv6> <ip-address> mac <mac-address>	Configure a static IPv4 or IPv6 neighbor.
output-vlan-map	Configure Output VLAN mapping
output-vlan-map vlan-operation	Specifies the VLAN operation at egress
output-vlan-map vlan-priority-operation	Specifies the VLAN priority operation, which allows users to configure the outer-VLAN-priority bits to remain transparent.
output-vlan-map inner-vlan-id <inner-vlan-id>	Configure the inner VLAN for the VLAN operation specified
output-vlan-map vlan-encapsulation <802.1ad | 802.1q>	VLAN encapsulation at egress
output-vlan-map vlan-id <vlan-id>	Configure the VLAN for the VLAN operation specified

Attribute	Description
output-vlan-map vlan-operation <push | pop | swap | push-push | pop-pop | swap-swap | swap-push | pop-swap>	VLAN operation at egress
unnumbered interface <loopback-interface-name>	Configure an unnumbered interface. See the Unnumbered Interface Configuration example below.
ra-disable true	Disable the router advertisement functionality.
service-meta-data	Configure layer-2 service egress meta data value.
statistics <false | true>	Enable traffic statistics for the L2 logical interfaces (L2 IFLs). For L3 logical interfaces (L3 IFLs), traffic statistics are enabled by default. The value true indicates enabled, and the value false indicates disabled.
vlan <outer-vlan-id>	Specifies Outer VLAN ID.
vlan-encapsulation <802.1ad | 802.1q>	Specifies the outer VLAN tag.

Example 1: Logical Interface Configuration with IPv4 MTU Profile

```
{
  "rtbrick-config:interface": [
     {
       "name": "ifp-0/0/1",
       "unit": [
         {
           "unit-id": 1,
           "description": "VLAN 101",
           "instance": "default",
           "ipv4-mtu-profile": "ipv4Mtu"

         }
       ]
     }
  ]
}
```

Example 2: Logical Interface Configuration with IPv6 MTU Profile

```
{
  "rtbrick-config:interface": [
     {
```

```
        "name": "ifp-0/0/1",
        "unit": [
          {
            "unit-id": 1,
            "description": "VLAN 101",
            "instance": "default",
            "ipv6-mtu-profile": "ipv6Mtu"

          }
        ]
      }
   ]
}
```

Example 3: Logical Interface Configuration with IP MTU Profile

```
 {
   "rtbrick-config:interface": [
      {
        "name": "ifp-0/0/1",
        "unit": [
          {
            "unit-id": 1,
            "description": "VLAN 101",
            "instance": "default",
            "ip-mtu-profile": "ipMtu"

          }
        ]
      }
   ]
}
```

Example 4: Logical Interface Configuration with disabling router advertisement

```
{
  "ietf-restconf:data": {
    "rtbrick-config:interface": [
      {
        "name": "ifp-0/0/1",
        "ifp": "L1-4-S1"
      },
      {
        "name": "hostif-0/0/2",
        "ifp": "L1-5-SN",
        "unit": [
          {
            "unit-id": 10,
            "ra-disable": "true"
          }
        ]
      },
    ]
  }
}
```

Example 5: Unnumbered Interface Configuration

The following configuration sets up a loopback interface lo-0/0/0/0 with IP addresses, and creates two unnumbered interfaces that inherits or borrows the IP addresses from the loopback interface.

```
supervisor@rtbrick: cfg> set interface lo-0/0/0 unit 0 instance service
supervisor@rtbrick: cfg> set interface lo-0/0/0 unit 0 address ipv4 192.0.2.1/32
supervisor@rtbrick: cfg> set interface lo-0/0/0 unit 0 address ipv6
2001:db8::1/128

supervisor@rtbrick: cfg> set interface ifp-0/0/25 unit 0 unnumbered interface lo-
0/0/0/0
supervisor@rtbrick: cfg> set interface ifp-0/0/25 unit 1 unnumbered interface lo-
0/0/0/0
supervisor@rtbrick: cfg> commit
```

```
supervisor@rtbrick: cfg> #show config interface#
{
  "rtbrick-config:interface": [
    {
      "name": "ifp-0/0/25",
      "unit": [
        {
          "unit-id": 0,
          "instance": "service",
          "vlan": 20,
          "unnumbered": {
            "interface": "lo-0/0/0/0"
          }
        },
        {
          "unit-id": 1,
          "instance": "service",
          "vlan": 21,
          "unnumbered": {
            "interface": "lo-0/0/0/0"
          }
        }
      ]
    },
    {
      "name": "lo-0/0/0",
      "unit": [
        {
          "unit-id": 0,
          "instance": "service",
          "address": {
            "ipv4": [
              {
                "prefix4": "192.168.1.1/32"
              }
            ],
            "ipv6": [
              {
                "prefix6": "192:168:1::1/128"
```

```
            }
          ]
        }
      }
    ]
  }
]
}
```

Example 6: The following example configures the interface (ifp-0/1/10 unit 10) to ignore outer-VLAN-priority rewrite operations by setting the vlan-priority-operation to none within the output-vlan-map configuration.

```
supervisor@rtbrick>SPINE01: cfg> set interface ifp-0/1/10 unit 10 output-vlan-map
supervisor@rtbrick>SPINE01: cfg> set interface ifp-0/1/10 unit 10 output-vlan-map
vlan-priority-operation none
```

```
{
  "rtbrick-config:interface": [
     {
       "name": "ifp-0/0/1",
       "unit": [
         {
           "unit-id": 1,
           "description": "VLAN 101",
           "instance": "default",
           "output-vlan-map":
             "vlan-priority-operation": none
         }
       ]
     }
  ]
}
```

API To access the RESTCONF API that corresponds to this CLI, click here.

Configuring IPv6 and MPLS Address Families on Logical Interfaces

You can explicitly enable IPv6 and MPLS address families on the required logical interfaces. Use the following configuration commands to enable IPv6 and MPLS address families on logical interfaces.

set interface <interface-name> **unit** <unit id> **ipv6-admin-status up**
set interface <interface-name> **unit** <unit id> **mpls-admin-status up**

Attribute	Description
<interface-name>	Name of the interface.
unit <unit-id>	Create a logical interface (also referred to as a sub-interface) under the physical interface.
ipv6-admin-status up	Enable IPv6 protocol processing on the interface unit.
mpls-admin-status up	Enables IPv6 MPLS protocol processing on the interface unit.

This configuration example below enables IPv6 and MPLS address families on multiple logical units of interface ifp-0/0/16. The 'ipv6-admin-status' and 'mpls-admin-status' options are specified as 'up', indicating that the address families are enabled in the specified units of the interface ifp-0/0/16. Each unit is mapped to a separate routing instance and assigned IPv4 and/or IPv6 addresses.

```
set interface ifp-0/0/16 speed 10G
set interface ifp-0/0/16 unit 1 ipv6-admin-status up
set interface ifp-0/0/16 unit 1 mpls-admin-status up
set interface ifp-0/0/16 unit 1 instance radius-vrf
set interface ifp-0/0/16 unit 1 vlan 100
set interface ifp-0/0/16 unit 1 address ipv4 192.0.2.1/24
set interface ifp-0/0/16 unit 10 ipv6-admin-status up
set interface ifp-0/0/16 unit 10 mpls-admin-status up
set interface ifp-0/0/16 unit 10 instance vrf1
set interface ifp-0/0/16 unit 10 address ipv4 192.0.2.2/24
set interface ifp-0/0/16 unit 10 address ipv6 2001:db8:0:0:1:0:0:1/64
```

```
supervisor@rtbrick.net: op> show config interface ifp-0/0/16
{
  "rtbrick-config:interface": [
    {
      "name": "ifp-0/0/16",
      "speed": "10G",
      "unit": [
        {
          "unit-id": 1,
          "ipv6-admin-status": "up",
          "mpls-admin-status": "up",
          "instance": "radius-vrf",
          "vlan": 100,
          "address": {
            "ipv4": [
              {
                "prefix4": "192.0.2.1/24"
              }
            ]
          }
        },
```

```
        {
          "unit-id": 10,
          "ipv6-admin-status": "up",
          "mpls-admin-status": "up",
          "instance": "vrf1",
          "address": {
            "ipv4": [
              {
                "prefix4": "192.0.2.2/24"
              }
            ],
            "ipv6": [
              {
                "prefix6": "2001:db8:0:0:1:0:0:1/64"
              }
            ]
          }
        }
      ]
    }
  ]
}
```


Interface Address Configuration

This section describes how to configure interface IP addresses.

Syntax:

set interface <interface-name> **unit** <unit-id> **address** <afi> <attribute> <value>

Attribute	Description
<afi>	Address family identifier (AFI). Supported values: ipv4 and ipv6
<prefix4|prefix6>	Assign IPv4 or IPv6 address to the interface unit.
community <community-value>	Configure list of communities associated with the address.
extended-community <community-value>	Configure list of extended communities associated with the address.

Attribute	Description
label <label-value>	Configure label associated with the address. Supported MPLS label values are 0 - 1048575. The reserved MPLS label range is 0 - 15. In RBFS, BGP uses the label range 20000 - 100000. It is recommended to assign label values outside of these reserved ranges to avoid conflicts.
secondary true	Enable a secondary IPv4 address. To disable the secondary IP configuration, use the delete form of the command.



Broadcast and network IP addresses cannot be configured on logical (IFL) interfaces.

Example: Interface Address Configuration

```
{
    "rtbrick-config:interface": [
      {
        "name": "lo-0/0/1",
        "unit": [
          {
            "unit-id": 1,
            "address": {
              "ipv4": [
                {
                  "prefix4": "198.51.100.103/24",
                  "label": 12346
                }
              ]
            }
          }
        ]
      }
    ]
  }
```



To access the RESTCONF API that corresponds to this CLI, click here.

Global Interface Configuration

This section describes a configuration option applied globally to all interfaces.

Syntax:

set global interface all <attribute> <value>

Attribute	Description
admin-status <up|down>	Configure state of the interface.



- The interface level enable/disable command has higher precedence than the global interface enable/disable command.
- You can disable all unused physical interfaces.
- Before executing the global interface disable all command ensure that all physical interfaces are in the link Up state.

Example: Enabling or Disabling all Interfaces

```
{
  "ietf-restconf:data": {
    "rtbrick-config:global": {
      "interface": {
        "all": {
          "admin-status": "down"
        }
      }
    }
  }
}
```

Interface Holddown Configuration

By default, the Interface Hold-down feature is enabled. You can disable the feature if you want. It is allowed to configure timer value for options such as 'holddown down delay' and 'holddown up delay'.

Syntax:

set interface <interface-name> <attribute> <value>

Attribute	Description
<interface-name>	Name of the interface. Example: ifp-0/0/1.

Attribute	Description
holddown <disable|enable>	Enable or disable the holddown timer feature. By default, the feature is enabled.
holddown-down-delay	Configure the down delay time in milliseconds (ms). The allowed values include 0, 100, 200, 500, 1000, 2000, 5000, and 10000. Default 0 ms.
holddown-up-delay	Configure the up delay time milliseconds (ms). The allowed values include 0, 100, 200, 500, 1000, 2000, 5000, and 10000. Default range 0 - 10000 ms.

IPv6 Link-Local Address Configuration

You can manually assign an IPv6 link-local address on an interface.

Syntax:

set interface <interface-name> **unit** <unit-id> **address ipv6-link-local** <IPv6 address>

Attribute	Description
<interface-name>	Name of the interface. Example: ifp-0/0/1.
unit <unit-id>	Create a logical interface (also referred to as a sub-interface) under the physical interface.
ipv6-link-local <IPv6 address>	Specifies the IPv6 link-local address.

Example for IPv6 link-local configuration

```
{
 "ietf-restconf:data": {
   "rtbrick-config:interface": [
     {
       "name": "hostif-0/0/0",
       "host-if": "B1-1-SN"
     },
     {
       "name": "hostif-0/0/2",
       "host-if": "B1-3-B2",
       "unit": [
         {
           "unit-id": 10,
           "address": {
             "ipv6-link-local": "fe80::1"
```

```
            }
          }
        ]
      },
      {
        "name": "hostif-0/0/3",
        "host-if": "B1-4-B2"
      }
    ]
  }
}
```

Disabling Gratuitous ARP on Interface

You can disable the sending of Gratuitous ARP (GARP) on an interface, which is enabled by default on all interfaces.



To enable GARP on an interface, you need to delete the garp-disable true configuration.

Syntax:

set interface <interface-name> **unit** <unit-id> **garp-disable true**

Attribute	Description
interface <interface-name>	Name of the interface. Examples: ifp-0/0/1.
garp-disable true	Disables Gratuitous ARP (GARP). Default is GARP enabled.

Example: Disabling Gratuitous ARP

```
supervisor@rtbrick.net: cfg> set interface ifp-0/0/0 unit 100 garp-disable true
```

Static ARP Entry Configuration on Logical Interfaces

This static ARP Entry on IFLs enables the RBFS devices to proactively resolve ARP and ND.

Syntax:

set interface <interface> unit <unit id> **neighbor** < **ipv4** | **ipv6** > <ip

```
address> dynamic true
```

The following example shows how to configure an ARP entry on a logical interface.

```
set interface ifp-0/1/0 unit 6 neighbor ipv4 192.0.2.1 dynamic true
```

Example:

```
{
  "ietf-restconf:data": {
    "rtbrick-config:interface": [
      {
        "name": "ifp-0/1/0",
        "host-if": "S1-1-SN",
        "unit": [
          {
            "unit-id": 10,
            "neighbor": {
              "ipv4": [
                {
                  "address": "192.0.2.1",
                  "dynamic": "true"
                }
              ]
            }
          }
        ]
      },
      {
        "name": "ifp-0/0/1",
        "host-if": "S1-2-SN"
      },
      {
        "name": "ifp-0/0/2",
        "host-if": "S1-3-L1"
      },
      {
        "name": "ifp-0/0/3",
        "host-if": "S1-4-L1"
      }
    ]
  }
}
```

API To access the RESTCONF API that corresponds to this CLI, click here.

Breakout Interfaces

RBFS supports breakout for 100G interfaces on the UfiSpace S9600-32X and EdgeCore AGR400 (AS7946-30XB) platforms. Using the breakout configuration, the high-speed interfaces(100G) on the UfiSpace S9600-32X platform and EdgeCore

AGR400 (AS7946-30XB) can be divided into multiple lower-speed interfaces(10G or 25G), allowing them to connect with lower rate ports(10G or 25G) in other network devices.

RBFS supports the following breakout configuration options:

Rate	Technology	Breakout Capable	Electric Lanes	Optical Lanes
100G	QSFP28	Yes	4 x 25G	4 x 25G
100G	QSFP28	Yes	4 x 10G	4 x 10G

For example, to set up the individual peer-side (25G/10G) interfaces, we need to configure the breakout on the 100G port to 4x10G or 4x25G based on the peer-side speed.

When a breakout is configured on a high-speed interface (for example, ifp-0/1/12), it is divided into four lower-speed interfaces: ifp-0/1/12#0, ifp-0/1/12#1, ifp-0/1/12#2, and ifp-0/1/12#3. As a result, the original high-speed interface will no longer be available.

The following diagram shows the breakout for the interface ifp-0/1/12 on the high-speed 100G to 4 x 25G ports (0, 1, 2, 3).

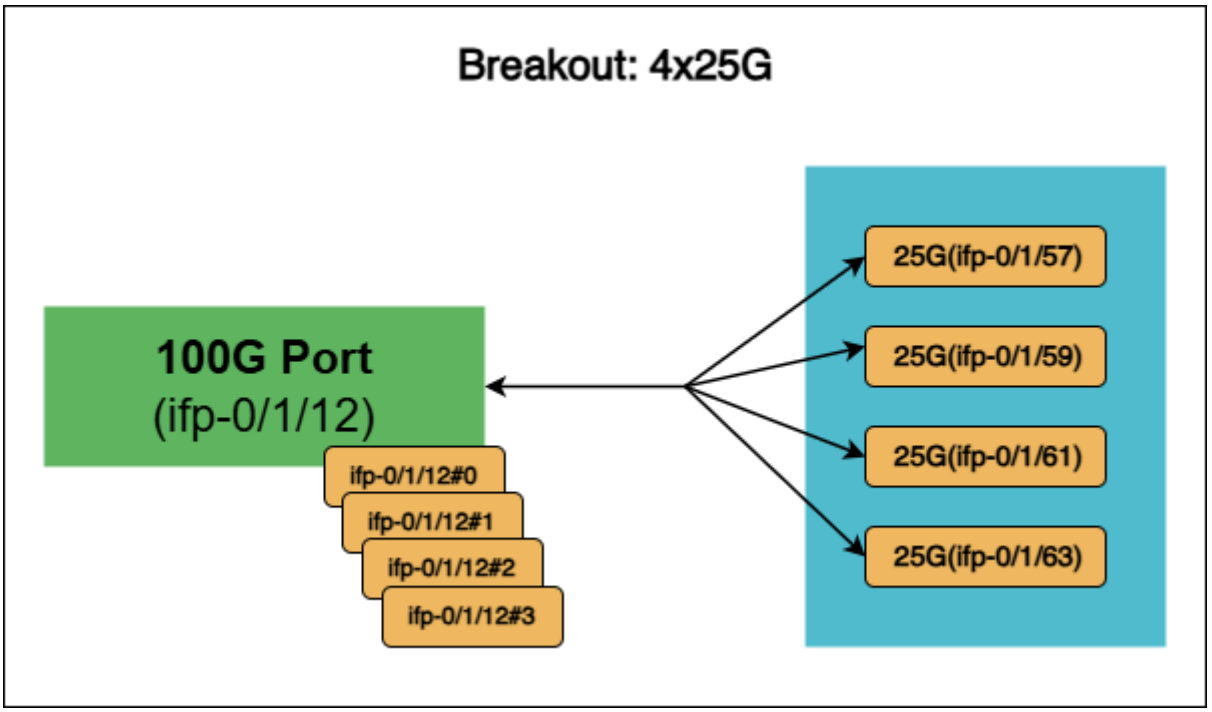


Figure 113. Breakout Configuration

Guidelines and Limitations

Currently, the following limitations exist.

- Autonegotiation, speed configuration, and traffic sampling are not supported for breakout interfaces.
- A breakout interface cannot be a member of a LAG.
- Using breakout interfaces with routing protocols is not supported.

Configuring Breakout

To configure for the interface ifp-0/1/12 on the high-speed 100G to 4x25G ports., enter the following command:

Syntax:

set interface <interface-name> **breakout map** <4x10G | 4x25G>

Example:

```
set interface ifp-0/1/12 breakout map 4x25G
```

Viewing Breakout Configuration Details

To view the breakout configuration details, enter the following command:

```
show interface <interface-name> detail
```

Example output for a specified interface.

```
supervisor@rtbrick.net: cfg> show interface ifp-0/1/0 detail
Interface:ifp-0/1/0
  Admin/Link/Operational status: Down/Down/Down
  Damping Status: stable
  Speed configured: 10G
  Speed maximum: 25G
  Duplex: Full
  Encapsulation mode: ieee
  MRU: 10000
  MTU: 9000
  Forward Error Correction: none
  Maximum frame size: 10000
  Interface type: ethernet
```

```
  Interface index: 2305
  MAC: e8:c5:7a:d5:f9:33
  Uptime:  never, Holddown up/down delay: 10000ms/0ms
  Flap count:  2
  Holddown transitions:  1
  Description: Physical interface #0 from node 0, chip 1
  LED Status: Off, LED programmed value: 10
  Packet statistics:
    Rx packets: 0          Tx packets: 714
    Rx bytes: 0            Tx bytes: 89250
```

Example of Breakout Configuration:

```
supervisor@rtbrick>SPINE01: cfg> show interface ifp-0/1/12#0 detail
Interface: ifp-0/1/12#0
  Admin/Link/Operational status: Up/Up/Up
  Damping Status: holddown
  Breakout: 4x25G
  Speed configured: 25G
  Speed maximum: 25G
  Duplex: Full
  Encapsulation mode: ieee
  MRU: 10000
  MTU: 9000
  Maximum frame size: 10000
  Interface type: ethernet
  Interface index: 100609
  MAC: e8:c5:7a:8f:56:c6
  Uptime:  Mon Nov 25 05:37:10 GMT +0000 2024, Holddown up/down delay: 10000ms/0ms
  Flap count:  1
  Holddown transitions:  1
  Description: Physical interface $$#$$12 from node 0, chip 1
  LED Status: Off, LED programmed value: 82
  Packet statistics:
    Rx packets: 3          Tx packets: 3
    Rx bytes: 381          Tx bytes: 387
```

```
supervisor@rtbrick>SPINE01: cfg> show interface ifp-0/1
/12#1 detail
Interface: ifp-0/1/12#1
  Admin/Link/Operational status: Up/Up/Up
  Damping Status: stable
  Breakout: 4x25G
  Speed configured: 25G
  Speed maximum: 25G
  Duplex: Full
  Encapsulation mode: ieee
  MRU: 10000
  MTU: 9000
  Maximum frame size: 10000
  Interface type: ethernet
  Interface index: 102657
  MAC: e8:c5:7a:8f:56:c7
  Uptime:  Mon Nov 25 05:37:10 GMT +0000 2024, Holddown up/down delay: 10000ms/0ms
  Flap count:  1
  Holddown transitions:  1
  Description: Physical interface $$#$$12 from node 0, chip 1
```

```
  LED Status: Off, LED programmed value: 4
  Packet statistics:
    Rx packets: 1          Tx packets: 1
    Rx bytes: 127          Tx bytes: 129
```

```
supervisor@rtbrick>SPINE01: cfg> show interface ifp-0/1
/12#2 detail
Interface: ifp-0/1/12#2
  Admin/Link/Operational status: Up/Up/Up
  Damping Status: stable
  Breakout: 4x25G
  Speed configured: 25G
  Speed maximum: 25G
  Duplex: Full
  Encapsulation mode: ieee
  MRU: 10000
  MTU: 9000
  Maximum frame size: 10000
  Interface type: ethernet
  Interface index: 104705
  MAC: e8:c5:7a:8f:56:c8
  Uptime:  Mon Nov 25 05:37:10 GMT +0000 2024, Holddown up/down delay: 10000ms/0ms
  Flap count:  1
  Holddown transitions:  1
  Description: Physical interface $$#$$12 from node 0, chip 1
  LED Status: Off, LED programmed value: 0
  Packet statistics:
    Rx packets: 1          Tx packets: 1
    Rx bytes: 127          Tx bytes: 129
```

```
supervisor@rtbrick>SPINE01: cfg> show interface ifp-0/1
/12#3 detail
Interface: ifp-0/1/12#3
  Admin/Link/Operational status: Up/Up/Up
  Damping Status: stable
  Breakout: 4x25G
  Speed configured: 25G
  Speed maximum: 25G
  Duplex: Full
  Encapsulation mode: ieee
  MRU: 10000
  MTU: 9000
  Maximum frame size: 10000
  Interface type: ethernet
  Interface index: 106753
  MAC: e8:c5:7a:8f:56:c9
  Uptime:  Mon Nov 25 05:37:10 GMT +0000 2024, Holddown up/down delay: 10000ms/0ms
  Flap count:  1
  Holddown transitions:  1
  Description: Physical interface $$#$$12 from node 0, chip 1
  LED Status: Off, LED programmed value: 0
  Packet statistics:
    Rx packets: 1          Tx packets: 1
    Rx bytes: 127          Tx bytes: 129
```

Split Horizon for P2MP Interface

Split Horizon for P2MP Interface improves security and traffic control by preventing direct communication between devices connected to the same Point-to-Multipoint (P2MP) interface. Currently, in a P2MP setup where multiple devices (like OLTs) are connected to a single interface, these devices can communicate directly with each other. This is often undesirable for security and network management.

Therefore, a no-local-routing configuration knob for P2MP interfaces is made available. When enabled, this feature will block direct communication between hosts connected to the same P2MP interface.

When no-local-routing true is configured on an interface (e.g., a loopback interface associated with the P2MP interface), the system will automatically create Access Control Lists (ACLs) to:

- **Block**: Traffic originating from the P2MP subnet and destined for the same P2MP subnet. This prevents communication between devices on that P2MP interface.
- **Allow**: Traffic from the P2MP subnet to the interface's own IP address, allowing traffic to the gateway from the client.

Enabling split horizon provides these key advantages:

- **Improved Security**: Prevents unauthorized communication between devices within the same P2MP segment, isolating them from each other.
- **Enhanced Network Control**: Gives administrators granular control over traffic flow on P2MP interfaces.
- **Compliance**: Helps meet security requirements that mandate isolation between network segments or connected devices.
- **Simplified Configuration**: A single configuration knob, no-local-routing true, simplifies the process of implementing split horizon, as the system automatically manages the underlying ACLs.



This feature is supported on all platforms except the QAX platform.

Configuring Split Horizon

The Split Horizon for P2MP Interface feature enhances network security and control for Point-to-Multipoint (P2MP) interfaces.

Syntax:

set interface <interface-name> **unit** <unit-number> **address** <address> **no-local-routing true**

Attribute	Description
interface-name	The name of the interface to configure (e.g., lo-0/0/6 for a loopback interface).
unit-number	The unit number of the interface (e.g., 4).
address	The IP address to assign to the interface (e.g., 198.51.100.1/24).
address no-local-routing true	Enables split horizon by preventing local routing on the interface, blocking traffic between devices on the same P2MP interface.

The example below configures a loopback interface (lo-0/0/6 unit 4) with an IPv4 address and enables no-local-routing true for split horizon. It also configures a VLAN interface (ifp-0/1/14 unit 4) as unnumbered, inheriting its IP from the loopback, to separate management and in-band traffic and prevent routing loops.

```
set interface lo-0/0/6 unit 4 description "lo0.4 dhcp_relay"
set interface lo-0/0/6 unit 4 instance dpu_mgmt
set interface lo-0/0/6 unit 4 address ipv4 198.51.100.1/24 no-local-routing true
set interface ifp-0/1/14 unit 4 description "VLAN4 dpu_inband"
set interface ifp-0/1/14 unit 4 instance dpu_mgmt
set interface ifp-0/1/14 unit 4 vlan 4
set interface ifp-0/1/14 unit 4 unnumbered interface lo-0/0/6/4
set interface ifp-0/1/14 unit 4 garp-disable true
```

```
{
  "rtbrick-config:interface": [
    {
      "name": "ifp-0/1/14",
      "unit": [
        {
          "unit-id": 4,
          "description": "VLAN4 dpu_inband",
```

```
          "instance": "dpu_mgmt",
          "vlan": 4,
          "unnumbered": {
            "interface": "lo-0/0/6/4"
          },
          "garp-disable": "true"
        }
      ]
    },
    {
      "name": "lo-0/0/6",
      "unit": [
        {
          "unit-id": 4,
          "description": "lo0.4 dhcp_relay",
          "instance": "dpu_mgmt",
          "address": {
            "ipv4": [
              {
                "prefix4": "198.51.100.1/24",
                "no-local-routing": "true"
              }
            ]
          }
        }
      ]
    }
  ]
}
```

Support for FEC Bypass

RBFS supports Forward Error Correction (FEC) bypass on high-speed Ethernet interfaces. It allows low-latency operation by enabling FEC to be bypassed while preserving link compatibility. In latency-sensitive environments such as high-frequency trading, disabling FEC helps to reduce end-to-end latency. FEC bypass requires coordination with the link partner (at the other end), as the receiver must be aware that FEC is not applied.

When enabled, the transmitter explicitly signals the FEC bypass status to the link partner, preventing link failures caused by FEC mismatches.

Syntax:

set interface <interface-name> **forward-error-correction-bypass** <disable | enable>

Attribute	Description
<interface-name>	Name of the physical interface.
forward-error-correction-bypass <disable | enable>	When specify 'enable', the interface operates without applying FEC and reduces the processing latency. When disabled, the interface uses standard FEC operation as defined.

Example Command:

The following example configuration enables FEC bypass on the specified interface. It indicates that traffic on this interface will operate without FEC processing to support low-latency operation.

```
set interface ifp-0/1/8 forward-error-correction-bypass enable
```

```
{
  "rtbrick-config:interface": [
    {
      "name": "ifp-0/1/8",
      "speed": "10G",
      "forward-error-correction-bypass": "enable"
    }
  ]
}
```

Enabling TTL Inheritance from IP to MPLS

You can enable the inheritance of the IP TTL into the MPLS TTL at the ingress node by enabling TTL propagation.



By default, the IP TTL is not inherited at the MPLS ingress node and the MPLS TTL is set to the value '64'. To enable this feature, use the following configuration command:

Syntax:

set forwarding-options ttl propagate enable

Attribute	Description
ttl propagate enable	Enables the router to inherit the incoming packet's IP TTL to the outgoing packet's MPLS TTL.

Example:

The following configuration allows the device to inherit the incoming IP TTL/hop-limit into the MPLS TTL.

```
set forwarding-options ttl propagate enable
```

```
{
  "rtbrick-config:ttl": {
    "propagate": "enable"
  }
}
```

Enabling Reverse Path Forwarding

This configuration enbles Reverse Path Forwarding (RPF) on an interface unit. Packets received on IFLs can be validated against their expected reverse path.

Syntax:

set interface <name> **unit** <unit-id> **rpf** [**loose** | **strict**]

Attribute
Description
<unit-id>
Logical interface number.
strict
Accepts the incoming packet only if the source IP address is reachable through the same interface on which the packet is received.
loose
Accepts the incoming packet if the source IP address exists in the routing table, regardless of the incoming interface.

The following configuration enables Reverse Path Forwarding on the specified interface unit to validate the source of incoming IP packets. This helps prevent IP spoofing by ensuring that packets are received on a valid and reachable path, based on the configured validation mode, that is 'strict'.

```
set interface ifp-0/0/16 unit 100 rpf strict
```

```
{
  "interfaces": [
    {
      "name": "ifp-0/0/16",
      "unit": [
        {
          "unit-id": 100,
          "rpf": {
            "mode": "strict"
          }
        }
      ]
    }
  ]
}
```

6.1.3. Interfaces Operational Commands

Interface Show Commands

The interface show commands provide detailed information about the status and parameters of RBFS interfaces.

Interface Summary Commands

Syntax:

show interface <option>

Option	Description
summary	Displays a summary of all interfaces including physical, logical, and address information.
<interface-name>	Displays a summary of an interface including physical, logical, and address information.

Option	Description
physical	Displays all physical interface including loopback, cpu and recycle ports.
logical	Displays all logical interfaces for all instances.
logical <instance-name>	Displays all logical interfaces for the given instance.
address	Displays all IPv4 and IPv6 addresses for all instances.
address <instance-name>	Displays all IPv4 and IPv6 addresses for the given instance.

Example 1: Summary Output for All Interfaces

```
supervisor@rtbrick>LEAF01: op> show interface summary
Interface               Admin    Link     Oper          IPv4 Address            IPv6 Address
ifp-0/0/1               Up       Down     Down
ifp-0/0/2               Up       Down     Down
ifp-0/0/3               Up       Down     Down
ifp-0/0/4               Up       Up       Up
ifp-0/0/5               Up       Down     Down
ifp-0/0/6               Up       Down     Down
ifp-0/0/7               Up       Down     Down
ifp-0/0/8               Up       Down     Down
ifp-0/0/9               Up       Down     Down
ifp-0/0/10              Up       Up       Up
ifl-0/0/10/100          Up       Up       Up            198.51.100.22/24        2001:db8:0:100::/32
ifl-0/0/10/200          Up       Up       Up            198.51.100.32/24        2001:db8:0:10::/32
ifl-0/0/10/300          Up       Up       Up            -                       2001:db8:0:160::/32
ifp-0/0/11              Up       Down     Down
ifp-0/0/12              Up       Down     Down
ifp-0/0/13              Up       Down     Down
ifp-0/0/14              Up       Down     Down
ifp-0/0/15              Up       Down     Down
ifp-0/0/16              Up       Down     Down
ifp-0/0/17              Up       Down     Down
ifp-0/0/18              Up       Down     Down
ifp-0/0/19              Up       Down     Down
ifp-0/0/20              Up       Down     Down
ifp-0/0/21              Up       Down     Down
ifp-0/0/22              Up       Down     Down
ifp-0/0/23              Up       Down     Down
ifp-0/0/24              Up       Down     Down
ifp-0/0/25              Up       Down     Down
ifp-0/0/26              Up       Down     Down
ifp-0/0/27              Up       Up       Up
ifp-0/0/28              Up       Down     Down
ifp-0/0/29              Up       Down     Down
ifp-0/0/30              Up       Down     Down
ifp-0/0/31              Up       Down     Down
ifp-0/0/32              Up       Down     Down
ifp-0/0/33              Up       Down     Down
ifp-0/0/34              Up       Down     Down
ifp-0/0/35              Up       Down     Down
ifp-0/0/36              Up       Down     Down
ifp-0/0/37              Up       Down     Down
ifp-0/0/38              Up       Down     Down
ifp-0/0/39              Up       Down     Down
ifp-0/0/40              Up       Down     Down
ifp-0/0/41              Up       Down     Down
ifp-0/0/42              Up       Down     Down
ifp-0/0/43              Up       Down     Down
```

```
ifp-0/0/44               Up       Down     Down
ifp-0/0/45               Up       Down     Down
ifp-0/0/46               Up       Down     Down
ifp-0/0/47               Up       Down     Down
ifp-0/0/48               Up       Down     Down
ifp-0/0/49               Up       Down     Down
ifp-0/0/50               Up       Down     Down
ifp-0/0/51               Up       Down     Down
ifp-0/0/52               Up       Up       Up
ifp-0/0/53               Up       Up       Up
ifp-0/0/54               Up       Down     Down
cpu-0/0/200              Up       Up       Up
cpu-0/0/201              Up       Down     Down
cpu-0/0/202              Up       Down     Down
cpu-0/0/203              Up       Down     Down
recycle-0/0/75           Up       Up       Up
recycle-0/0/75/0         Up       Up       Up
recycle-0/0/76           Up       Up       Up
recycle-0/0/76/0         Up       Up       Up
```

Example 2: Summary Output for One Physical Interface

```
supervisor@rtbrick>LEAF01: op> show interface ifp-0/0/10
Interface                Admin    Link     Oper          IPv4 Address             IPv6 Address
ifp-0/0/10               Up       Up       Up
  ifl-0/0/10/100         Up       Up       Up            198.51.100.22/24               2001:db8:0:100::/32
  ifl-0/0/10/200         Up       Up       Up            198.51.100.32/24               2001:db8:0:10::/32
  ifl-0/0/10/300         Up       Up       Up            -                        2001:db8:0:160::/32
  ifl-0/0/10/1000        Up       Up       Up            -                        2001:db8:0:33::/32
```

Example 3: List of All Physical Interfaces

```
supervisor@rtbrick>LEAF01: op> show interface physical
Interface        Admin   Link    Oper    MAC Address          Speed  Duplex  Uptime
lo-0/0/1         Up      Up      Up      80:a2:35:a0:00:01    -      -       Thu Nov 19 10:41:06 GMT +0000
2020
ifp-0/0/1        Up      Down    Down    80:a2:35:ee:a8:01    10G    Full    Mon Nov 16 11:24:09 GMT +0000
2020
ifp-0/0/2        Up      Down    Down    80:a2:35:ee:a8:02    10G    Full    Mon Nov 16 11:24:09 GMT +0000
2020
ifp-0/0/3        Up      Down    Down    80:a2:35:ee:a8:03    10G    Full    Mon Nov 16 11:24:09 GMT +0000
2020
ifp-0/0/4        Up      Up      Up      80:a2:35:ee:a8:04    10G    Full    Thu Nov 19 10:05:02 GMT +0000
2020
ifp-0/0/5        Up      Down    Down    80:a2:35:ee:a8:05    10G    Full    Mon Nov 16 11:24:09 GMT +0000
2020
ifp-0/0/6        Up      Down    Down    80:a2:35:ee:a8:06    10G    Full    Mon Nov 16 11:24:09 GMT +0000
2020
ifp-0/0/7        Up      Down    Down    80:a2:35:ee:a8:07    10G    Full    Mon Nov 16 11:24:09 GMT +0000
2020
ifp-0/0/8        Up      Down    Down    80:a2:35:ee:a8:08    10G    Full    Mon Nov 16 11:24:09 GMT +0000
2020
ifp-0/0/9        Up      Down    Down    80:a2:35:ee:a8:09    10G    Full    Mon Nov 16 11:24:09 GMT +0000
2020
ifp-0/0/10       Up      Up      Up      80:a2:35:ee:a8:0a    10G    Full    Fri Nov 20 00:59:12 GMT +0000
2020
ifp-0/0/11       Up      Down    Down    80:a2:35:ee:a8:0b    10G    Full    Mon Nov 16 11:24:09 GMT +0000
2020
ifp-0/0/12       Up      Down    Down    80:a2:35:ee:a8:0c    10G    Full    Mon Nov 16 11:24:09 GMT +0000
2020
ifp-0/0/13       Up      Down    Down    80:a2:35:ee:a8:0d    10G    Full    Mon Nov 16 11:24:09 GMT +0000
2020
ifp-0/0/14       Up      Down    Down    80:a2:35:ee:a8:0e    10G    Full    Mon Nov 16 11:24:09 GMT +0000
2020
ifp-0/0/15       Up      Down    Down    80:a2:35:ee:a8:0f    10G    Full    Mon Nov 16 11:24:09 GMT +0000
2020
ifp-0/0/16       Up      Down    Down    80:a2:35:ee:a8:10    10G    Full    Mon Nov 16 11:24:09 GMT +0000
```

```
2020
ifp-0/0/17       Up      Down    Down    80:a2:35:ee:a8:11    10G    Full    Mon Nov 16 11:24:09 GMT +0000
2020
ifp-0/0/18       Up      Down    Down    80:a2:35:ee:a8:12    10G    Full    Mon Nov 16 11:24:09 GMT +0000
2020
ifp-0/0/19       Up      Down    Down    80:a2:35:ee:a8:13    10G    Full    Mon Nov 16 11:24:09 GMT +0000
2020
ifp-0/0/20       Up      Down    Down    80:a2:35:ee:a8:14    10G    Full    Mon Nov 16 11:24:09 GMT +0000
2020
ifp-0/0/21       Up      Down    Down    80:a2:35:ee:a8:15    10G    Full    Mon Nov 16 11:24:09 GMT +0000
2020
ifp-0/0/22       Up      Down    Down    80:a2:35:ee:a8:16    10G    Full    Mon Nov 16 11:24:09 GMT +0000
2020
ifp-0/0/23       Up      Down    Down    80:a2:35:ee:a8:17    10G    Full    Mon Nov 16 11:24:09 GMT +0000
2020
ifp-0/0/24       Up      Down    Down    80:a2:35:ee:a8:18    10G    Full    Mon Nov 16 11:24:09 GMT +0000
2020
ifp-0/0/25       Up      Down    Down    80:a2:35:ee:a8:19    10G    Full    Mon Nov 16 11:24:09 GMT +0000
2020
ifp-0/0/26       Up      Down    Down    80:a2:35:ee:a8:1a    10G    Full    Mon Nov 16 11:24:09 GMT +0000
2020
ifp-0/0/27       Up      Up      Up      80:a2:35:ee:a8:1b    10G    Full    Fri Nov 20 00:59:11 GMT +0000
2020
ifp-0/0/28       Up      Down    Down    80:a2:35:ee:a8:1c    10G    Full    Mon Nov 16 11:24:09 GMT +0000
2020
ifp-0/0/29       Up      Down    Down    80:a2:35:ee:a8:1d    10G    Full    Mon Nov 16 11:24:09 GMT +0000
2020
ifp-0/0/30       Up      Down    Down    80:a2:35:ee:a8:1e    10G    Full    Mon Nov 16 11:24:09 GMT +0000
2020
ifp-0/0/31       Up      Down    Down    80:a2:35:ee:a8:1f    10G    Full    Mon Nov 16 11:24:09 GMT +0000
2020
ifp-0/0/32       Up      Down    Down    80:a2:35:ee:a8:20    10G    Full    Mon Nov 16 11:24:09 GMT +0000
2020
ifp-0/0/33       Up      Down    Down    80:a2:35:ee:a8:21    10G    Full    Mon Nov 16 11:24:09 GMT +0000
2020
ifp-0/0/34       Up      Down    Down    80:a2:35:ee:a8:22    10G    Full    Mon Nov 16 11:24:09 GMT +0000
2020
ifp-0/0/35       Up      Down    Down    80:a2:35:ee:a8:23    10G    Full    Mon Nov 16 11:24:09 GMT +0000
2020
ifp-0/0/36       Up      Down    Down    80:a2:35:ee:a8:24    10G    Full    Mon Nov 16 11:24:09 GMT +0000
2020
ifp-0/0/37       Up      Down    Down    80:a2:35:ee:a8:25    10G    Full    Mon Nov 16 11:24:09 GMT +0000
2020
ifp-0/0/38       Up      Down    Down    80:a2:35:ee:a8:26    10G    Full    Mon Nov 16 11:24:09 GMT +0000
2020
ifp-0/0/39       Up      Down    Down    80:a2:35:ee:a8:27    10G    Full    Mon Nov 16 11:24:09 GMT +0000
2020
ifp-0/0/40       Up      Down    Down    80:a2:35:ee:a8:28    10G    Full    Mon Nov 16 11:24:09 GMT +0000
2020
ifp-0/0/41       Up      Down    Down    80:a2:35:ee:a8:29    10G    Full    Mon Nov 16 11:24:09 GMT +0000
2020
ifp-0/0/42       Up      Down    Down    80:a2:35:ee:a8:2a    10G    Full    Mon Nov 16 11:24:09 GMT +0000
2020
ifp-0/0/43       Up      Down    Down    80:a2:35:ee:a8:2b    10G    Full    Mon Nov 16 11:24:09 GMT +0000
2020
ifp-0/0/44       Up      Down    Down    80:a2:35:ee:a8:2c    10G    Full    Mon Nov 16 11:24:09 GMT +0000
2020
ifp-0/0/45       Up      Down    Down    80:a2:35:ee:a8:2d    10G    Full    Mon Nov 16 11:24:09 GMT +0000
2020
ifp-0/0/46       Up      Down    Down    80:a2:35:ee:a8:2e    10G    Full    Mon Nov 16 11:24:09 GMT +0000
2020
ifp-0/0/47       Up      Down    Down    80:a2:35:ee:a8:2f    10G    Full    Mon Nov 16 11:24:09 GMT +0000
2020
ifp-0/0/48       Up      Down    Down    80:a2:35:ee:a8:30    10G    Full    Mon Nov 16 11:24:09 GMT +0000
2020
ifp-0/0/49       Up      Down    Down    80:a2:35:ee:a8:31    100G   Full    Mon Nov 16 11:24:09 GMT +0000
2020
ifp-0/0/50       Up      Down    Down    80:a2:35:ee:a8:35    100G   Full    Mon Nov 16 11:24:09 GMT +0000
2020
ifp-0/0/51       Up      Down    Down    80:a2:35:ee:a8:39    100G   Full    Mon Nov 16 11:24:09 GMT +0000
2020
ifp-0/0/52       Up      Up      Up      80:a2:35:ee:a8:3d    100G   Full    Tue Nov 17 14:10:46 GMT +0000
2020
ifp-0/0/53       Up      Up      Up      80:a2:35:ee:a8:41    100G   Full    Fri Nov 20 00:59:12 GMT +0000
2020
ifp-0/0/54       Up      Down    Down    80:a2:35:ee:a8:45    100G   Full    Mon Nov 16 11:24:09 GMT +0000
2020
```

```
cpu-0/0/200      Up      Up      Up      80:a2:35:ee:a8:c8    100G   Full    Mon Nov 16 11:24:11 GMT +0000
2020
cpu-0/0/201      Up      Down    Down    80:a2:35:ee:a8:c9    100G   Full    Mon Nov 16 11:24:09 GMT +0000
2020
cpu-0/0/202      Up      Down    Down    80:a2:35:ee:a8:ca    100G   Full    Mon Nov 16 11:24:09 GMT +0000
2020
cpu-0/0/203      Up      Down    Down    80:a2:35:ee:a8:cb    100G   Full    Mon Nov 16 11:24:09 GMT +0000
2020
recycle-0/0/75   Up      Up      Up      80:a2:35:ee:a8:4b    100G   Full    Mon Nov 16 11:24:11 GMT +0000
2020
recycle-0/0/76   Up      Up      Up      80:a2:35:ee:a8:4c    100G   Full    Mon Nov 16 11:24:11 GMT +0000
2020
```

Example 4: List of All Logical Interfaces for All Instances

```
supervisor@rtbrick>LEAF01: op> show interface logical
Interface              Instance            Admin   Link    Oper    Outer VLAN   Inner VLAN  IPv4 Status,MTU
IPv6 Status,MTU
ifl-0/0/10/100         default             Up      Up      Up      -            -           Up,1500
Up,1500
ifl-0/0/10/200         default             Up      Up      Up      200          -           Up,1500
Up,1500
ifl-0/0/10/300         default             Up      Up      Up      300          -           Up,1500
Up,1500
```

Example 5: List of Logical Interfaces for an Instance

```
supervisor@rtbrick: op> show interface logical instance default
Interface              Instance            Admin   Link    Oper    Outer VLAN   Inner VLAN  IPv4 Status,MTU
IPv6 Status,MTU
ifl-0/0/10/100         default             Up      Up      Up      -            -           Up,1500
Up,1500
ifl-0/0/10/200         default             Up      Up      Up      200          -           Up,1500
Up,1500
ifl-0/0/10/300         default             Up      Up      Up      300          -           Up,1500
Up,1500
```

Example 6: List of All Interface Addresses

```
supervisor@rtbrick: op> show interface address
Interface              Instance         IPv4 Address        IPv4 Primary   IPv6 Address
  ifl-0/0/10/100       default        198.51.100.22/24      True           2001:db8:0:100::/32
  ifl-0/0/10/200       default        198.51.100.32/24       True          2001:db8:0:10::/32
  ifl-0/0/10/300       default              -                              2001:db8:0:160::/32
```

API To access the Operational State API that corresponds to this CLI, click here.

Interface Details Commands

Syntax:

show interface <option> **detail**

Option	Description
detail	Without any additional option, displays detailed information for all interfaces.
<interface-name> detail	Displays detailed information for an interface.

Example 7: Detailed Information for a Physical Interface and Its Logical Interfaces

```
supervisor@rtbrick: op> show interface ifp-0/0/10 detail
Interface:ifp-0/0/10
  Admin/Link/Operational status: Up/Up/Up
  MRU: 10000
  MTU: 1514
  Interface type: ifp
  Interface index: 8198
  MAC: 7a:4a:14:c0:00:04
  Uptime:  Thu Apr 11 05:57:42 GMT +0000 2024
  Flap count:  2
  Description: Physical interface #4 from node 0, chip 0
  Interface: ifp-0/0/10, Instance: default
    Admin/Link/Operational status: Up/Up/Up
    IPv4/IPv6/MPLS Status: Up/Up/Up
    IPv4/IPv6/MPLS MTU: 1500/1500/1500
    Interface type: Logical Sub interface
    Interface index: 532486
    MAC: 7a:4a:14:c0:00:04
    IPv4 Address             IPv6 Address
    192.0.2.0/24             2001:DB8::/64
```

The following output shows the interface holddown details such as the damping state, transitions, and delay.

```
supervisor@rtbrick.net: cfg> show interface ifp-0/1/20 detail
Interface:ifp-0/1/20
  Admin/Link/Operational status: Up/Up/Up
  Damping Status: stable
  Speed configured: 10G
  Speed maximum: 25G
  Duplex: Full
  Encapsulation mode: ieee
  MRU: 10000
  MTU: 9000
  Maximum frame size: 10000
  Interface type: ethernet
  Interface index: 43265
  MAC: e8:c5:7a:b2:04:b4
  Uptime:  Fri Jul 05 06:19:12 GMT +0000 2024, Holddown up/down delay: 10000ms/0ms
  Flap count:  1
  Holddown transitions:  1
  Description: Physical interface #20 from node 0, chip 1
  Packet statistics:
    Rx packets: 59         Tx packets: 59
    Rx bytes: 7493         Tx bytes: 7493
```

The following show command output indicates the valid range for holddown-up-delay when it is not explicitly configured by the user.

```
supervisor@rtbrick.net: cfg> show interface ifp-0/0/15 detail
Interface: ifp-0/0/15
  Admin/Link/Operational status: Up/Up/Up
  Damping Status: stable
  Speed configured: 10G
  Speed maximum: 25G
  Duplex: Full
  Encapsulation mode: ieee
  MRU: 10000
  MTU: 9000
  Maximum frame size: 10000
  Interface type: ethernet
  Interface index: 73729
  MAC: e8:c5:7a:b5:d2:c0
  Uptime: Tue Dec 02 09:20:35 GMT +0000 2025, Holddown up/down delay: [0-
10000]ms/0ms
  Description: Physical interface #15 from node 0, chip 0
  Class-of-Service: _DEFAULT_IFP_QOS_PROFILE_
  LED Status: On
  Packet statistics:
    Rx packets: 1390       Tx packets: 4597
    Rx bytes: 110396       Tx bytes: 336514
Holddown up/down delay: [0-10000]ms/0ms
```

MTU Profile Show Command

Syntax:

show mtu profile <option>

Option	Description
-	Without any additional option, displays detailed information for all MTU profiles.
profile-name <mtu-profile-name>	MTU Profile Name

Example 8: Detailed Information About the MTU Profiles

```
supervisor@rtbrick>LEAF01: op> show mtu profile
Profile Name               Type         Size   Action
__default_pppoe__          pppoe        1492   drop
l3IpMtu                    ipv4         1300   drop
l3Ipv6Mtu                  ipv6         1300   drop
portMtu                    physical     1300   drop
```

```
portM2                      physical     1400   drop
portM5                      physical     1430   drop
supervisor@rtbrick>LEAF01: op>
```

Example 9: Display Information About the Specified MTU Profile

```
supervisor@rtbrick>LEAF01: op> show mtu profile profile-name l3IpMtu
Profile Name                Type         Size   Action
l3IpMtu                     ipv4         1300   drop
supervisor@rtbrick>LEAF01: op>
```

Interface Statistics Commands

Syntax:

show interface <interface-name> **statistics**

Option	Description
statistics	Without any additional option, displays statistics information for all interfaces.
<interface-name> statistics	Displays statistics information for an interface.

Example 10: Statistics Information for a Physical Interface and Its Logical Interfaces

```
supervisor@rtbrick>LEAF01: op> show interface ifp-0/0/10 statistics
Interface:  ifp-0/0/10
   Counter               Direction   Unit       Rx         Rx Diff    Rx Rate    Tx         Tx Diff    Tx Rate
   IPv4                  -           Packets    -          -          -          -          -          -
                                     Bytes      -          -          -          -          -          -
   IPv6                  -           Packets    -          -          -          -          -          -
                                     Bytes      -          -          -          -          -          -
   MPLS                  -           Packets    -          -          -          -          -          -
                                     Bytes      -          -          -          -          -          -
   Punt                  -           Packets    -          -          -          -          -          -
                                     Bytes      -          -          -          -          -          -
   Miss                  RX          Packets    -          -          -          -          -          -
                                     Bytes      -          -          -          -          -          -
   Drops                 -           Packets    4995       -          -          -          -          -
                                     Bytes      -          -          -          -          -          -
   Error                 RX          Packets    -          -          -          -          -          -
                                     Bytes      -          -          -          -          -          -
   Error                 TX          Packets    47         -          -          -          -          -
                                     Bytes      -          -          -          -          -          -
   No Buff               RX          Packets    -          -          -          -          -          -
                                     Bytes      -          -          -          -          -          -
   Traffic Statistics    -           Packets    4995       -          -          68492      -          -
                                     Bytes      489510     -          -          5869876    -          -
   Unicast Statistics    -           Packets    -          -          -          -          -          -
                                     Bytes      -          -          -          -          -          -
   Broadcast Statistics  -           Packets    -          -          -          -          -          -
                                     Bytes      -          -          -          -          -          -
```

```
Multicast Statistics  -          Packets    -         -         -         -         -         -
                                 Bytes      -         -         -         -         -         -
Bcm Statistics:
inOctets:                                  511632
inUcastPkts:                               0
inNonUcastPkts:                            5016
inErrors:                                  0
inUnknownProtos:                           0
outOctets:                                 6236484
outUcastPkts:                              0
outNonUcastPkts:                           68492
outErrors:                                 0
etherStatsDropEvents:                      0
etherStatsMulticastPkts:                   67718
etherStatsBroadcastPkts:                   5790
etherStatsUndersizePkts:                   0
etherStatsFragments:                       0
etherStatsOversizePkts:                    0
etherStatsOctets:                          6748116
etherStatsPkts:                            73508
etherStatsCollisions:                      0
etherStatsTXNoErrors:                      68492
etherStatsRXNoErrors:                      5016
ifInMulticastPkts:                         5016
ifOutBroadcastPkts:                        5790
ifOutMulticastPkts:                        62702
ifOutBroadcastPkts:                        5790
bcmReceivedUndersizePkts:                  0
bcmTransmittedUndersizePkts:               5790
bcmQmxDot1dBasePortDelayExceededDiscards: 0
bcmQmxDot1dBasePortMtuExceededDiscards:   0
bcmQmxDot1dTpPortInFrames:                 5016
bcmQmxDot1dTpPortOutFrames:                68492
bcmQmxEtherStatsPkts64Octets:              5790
bcmQmxEtherStatsPkts128to255Octets:        24
bcmQmxEtherStatsPkts256to511Octets:        0
bcmQmxEtherStatsPkts512to1023Octets:       0
bcmQmxEtherStatsPkts1024to1518Octets:      0
bcmQmxEtherRxOversizePkts:                 0
bcmQmxEtherTxOversizePkts:                 0
bcmQmxEtherStatsJabbers:                   0
bcmQmxEtherStatsCRCAlignErrors:            0
bcmQmxDot3StatsFCSErrors:                  0
bcmQmxDot3StatsSingleCollisionFrames:      0
bcmQmxDot3StatsMultipleCollisionFrames:    0
bcmQmxDot3StatsSQETTestErrors:             0
bcmQmxDot3StatsDeferredTransmissions:      0
bcmQmxDot3StatsLateCollisions:             0
bcmQmxDot3StatsExcessiveCollisions:        0
bcmQmxDot3StatsInternalMacTransmitErrors: 0
bcmQmxDot3StatsCarrierSenseErrors:         0
bcmQmxDot3StatsFrameTooLongs:              0
bcmQmxDot3StatsInternalMacReceiveErrors:   0
bcmQmxDot3StatsSymbolErrors:               0
bcmQmxDot3ControlInUnknownOpcodes:         0
bcmQmxDot3InPauseFrames:                   0
bcmQmxDot3OutPauseFrames:                  0
bcmQmxIfHCInOctets:                        511632
bcmQmxIfHCInUcastPkts:                     0
bcmQmxIfHCInMulticastPkts:                 5016
bcmQmxIfHCInBroadcastPkts:                 0
bcmQmxIfHCOutOctets:                       6236484
bcmQmxIfHCOutUcastPkts:                    0
bcmQmxIfHCOutMulticastPkts:                62702
bcmQmxIfHCOutBroadcastPckts:               5790
bcmQmxIeee8021PfcRequests:                 0
bcmQmxIeee8021PfcIndications:              0
bcmQmxBcmEtherStatsPkts1519to1522Octets:   0
bcmQmxBcmEtherStatsPkts1522to2047Octets:   0
bcmQmxBcmReceivedPkts64Octets:             0
bcmQmxBcmReceivedPkts65to127Octets:        5016
bcmQmxBcmReceivedPkts128to255Octets:       0
bcmQmxBcmReceivedPkts256to511Octets:       0
bcmQmxBcmReceivedPkts512to1023Octets:      0
bcmQmxBcmReceivedPkts1024to1518Octets:     0
bcmQmxBcmReceivedPkts1519to2047Octets:     0
```

```
   bcmQmxBcmTransmittedPkts64Octets:         5790
   bcmQmxBcmTransmittedPkts65to127Octets:    62678
   bcmQmxBcmTransmittedPkts128to255Octets:   24
   bcmQmxBcmTransmittedPkts256to511Octets:   0
   bcmQmxBcmTransmittedPkts512to1023Octets:  0
   bcmQmxBcmTransmittedPkts1024to1518Octets: 0
   bcmQmxBcmTransmittedPkts1519to2047Octets: 0
   bcmQmxBcmTransmittedPkts2048to4095Octets: 0
   bcmQmxBcmTransmittedPkts4095to9216Octets: 0

Logical Interface:  ifl-0/0/10/100, Physical Interface:  ifp-0/0/10
   Counter               Direction   Unit       Rx         Rx Diff    Rx Rate    Tx         Tx Diff   Tx Rate
   IPv4                  -           Packets    -          -          -          -          -          -
                                     Bytes      -          -          -          -          -          -
   IPv6                  -           Packets    -          -          -          -          -          -
                                     Bytes      -          -          -          -          -          -
   MPLS                  -           Packets    -          -          -          -          -          -
                                     Bytes      -          -          -          -          -          -
   Punt                  -           Packets    -          -          -          -          -          -
                                     Bytes      -          -          -          -          -          -
   Miss                  RX          Packets    -          -          -          -          -          -
                                     Bytes      -          -          -          -          -          -
   Drops                 -           Packets    4995       -          -          -          -          -
                                     Bytes      -          -          -          -          -          -
   Error                 RX          Packets    -          -          -          -          -          -
                                     Bytes      -          -          -          -          -          -
   Error                 TX          Packets    47         -          -          -          -          -
                                     Bytes      -          -          -          -          -          -
   No Buff               RX          Packets    -          -          -          -          -          -
                                     Bytes      -          -          -          -          -          -
   Traffic Statistics    -           Packets    4995       -          -          68492      -          -
                                     Bytes      489510     -          -          5869876    -          -
   Unicast Statistics    -           Packets    -          -          -          -          -          -
                                     Bytes      -          -          -          -          -          -
   Broadcast Statistics  -           Packets    -          -          -          -          -          -
                                     Bytes      -          -          -          -          -          -
   Multicast Statistics  -           Packets    -          -          -          -          -          -
                                     Bytes      -          -          -          -          -          -
   Packet Statistics:
     Ingress Forwarded Packets: 1810
     Ingress Forwarded Bytes:   184620
     Ingress Drop Packets:      1
     Ingress Drop Bytes:        102
     Egress Forwarded Packets:  0
     Egress Forwarded Bytes:    0
     Egress Drop Packets:       0
     Egress Drop Bytes:         0
Logical Interface:  ifl-0/0/10/200, Physical Interface:  ifp-0/0/10
   Counter               Direction   Unit       Rx         Rx Diff    Rx Rate    Tx         Tx Diff   Tx Rate
   IPv4                  -           Packets    -          -          -          -          -          -
                                     Bytes      -          -          -          -          -          -
   IPv6                  -           Packets    -          -          -          -          -          -
                                     Bytes      -          -          -          -          -          -
   MPLS                  -           Packets    -          -          -          -          -          -
                                     Bytes      -          -          -          -          -          -
   Punt                  -           Packets    -          -          -          -          -          -
                                     Bytes      -          -          -          -          -          -
   Miss                  RX          Packets    -          -          -          -          -          -
                                     Bytes      -          -          -          -          -          -
   Drops                 -           Packets    -          -          -          -          -          -
                                     Bytes      -          -          -          -          -          -
   Error                 RX          Packets    -          -          -          -          -          -
                                     Bytes      -          -          -          -          -          -
   Error                 TX          Packets    -          -          -          -          -          -
                                     Bytes      -          -          -          -          -          -
   No Buff               RX          Packets    -          -          -          -          -          -
                                     Bytes      -          -          -          -          -          -
   Traffic Statistics    -           Packets    -          -          -          6811       -          -
                                     Bytes      -          -          -          573170     -          -
   Unicast Statistics    -           Packets    -          -          -          -          -          -
                                     Bytes      -          -          -          -          -          -
   Broadcast Statistics  -           Packets    -          -          -          -          -          -
                                     Bytes      -          -          -          -          -          -
   Multicast Statistics  -           Packets    -          -          -          -          -          -
                                     Bytes      -          -          -          -          -          -
   Packet Statistics:
```

```
     Ingress Forwarded Packets: 0
     Ingress Forwarded Bytes:   0
     Ingress Drop Packets:      0
     Ingress Drop Bytes:        0
     Egress Forwarded Packets:  0
     Egress Forwarded Bytes:    0
     Egress Drop Packets:       0
     Egress Drop Bytes:         0
Logical Interface:  ifl-0/0/10/300, Physical Interface:  ifp-0/0/10
   Counter               Direction   Unit       Rx         Rx Diff    Rx Rate    Tx         Tx Diff    Tx Rate
   IPv4                  -           Packets    -          -          -          -          -          -
                                     Bytes      -          -          -          -          -          -
   IPv6                  -           Packets    -          -          -          -          -          -
                                     Bytes      -          -          -          -          -          -
   MPLS                  -           Packets    -          -          -          -          -          -
                                     Bytes      -          -          -          -          -          -
   Punt                  -           Packets    -          -          -          -          -          -
                                     Bytes      -          -          -          -          -          -
   Miss                  RX          Packets    -          -          -          -          -          -
                                     Bytes      -          -          -          -          -          -
   Drops                 -           Packets    -          -          -          -          -          -
                                     Bytes      -          -          -          -          -          -
   Error                 RX          Packets    -          -          -          -          -          -
                                     Bytes      -          -          -          -          -          -
   Error                 TX          Packets    -          -          -          -          -          -
                                     Bytes      -          -          -          -          -          -
   No Buff               RX          Packets    -          -          -          -          -          -
                                     Bytes      -          -          -          -          -          -
   Traffic Statistics    -           Packets    -          -          -          5902       -          -
                                     Bytes      -          -          -          531180     -          -
   Unicast Statistics    -           Packets    -          -          -          -          -          -
                                     Bytes      -          -          -          -          -          -
   Broadcast Statistics  -           Packets    -          -          -          -          -          -
                                     Bytes      -          -          -          -          -          -
   Multicast Statistics  -           Packets    -          -          -          -          -          -
                                     Bytes      -          -          -          -          -          -
   Packet Statistics:
     Ingress Forwarded Packets: 0
     Ingress Forwarded Bytes:   0
     Ingress Drop Packets:      0
     Ingress Drop Bytes:        0
     Egress Forwarded Packets:  0
     Egress Forwarded Bytes:    0
     Egress Drop Packets:       0
     Egress Drop Bytes:         0
```

Display RSFEC Error Counters

RSFEC error counters: FEC Bit Error Counter, FEC Correctable Counter, and FEC Uncorrectable Counter (bcmRxFecCorrectable, bcmRxFecUncorrectable, and bcmRxRsFecBitError) are visible in the CLI.

Example for RSFEC error counter statistics

```
supervisor@rtbrick.net: dbg> show interface ifp-0/0/3 statistics
Interface:  ifp-0/0/3
  VPP statistics
      Counter              Unit      Count
      Rx                   packets   67
                           bytes     7906
      Tx                   packets   68
                           bytes     8024
      IPv4                 packets   0
      IPv6                 packets   0
      MPLS                 packets   0
```

```
      Punt                packets   0
      Drops               packets   67
      Rx Miss             packets   0
      Rx Error            packets   0
      Rx No Buff          packets   0
      Tx Error            packets   0
  BCM statistics:
    rx_packets: 67                                        tx_packets: 67
    rx_bytes: 8174                                        tx_bytes: 8174
    ifHCInOctets: 8174                                    ifHCOutOctets: 8174
    inNonUcastPkts: 67                                    outNonUcastPkts: 67
    inErrors: 0                                           outErrors: 0
    etherStatsDropEvents: 0
etherStatsBroadcastPkts: 0
    etherStatsUndersizePkts: 0                            etherStatsFragments: 0
    etherStatsOversizePkts: 0                             etherStatsOctets: 8174
    etherStatsPkts: 67
dot1dBasePortMtuExceededDiscards: 0
    outMulticastPkts: 0                                   outBroadcastPkts: 0
    bcmReceivedUndersizePkts: 0
bcmTransmittedUndersizePkts: 0
    etherTxOversizePkts: 0                                etherStatsJabbers: 0
    etherStatsCRCAlignErrors: 0                           dot3StatsFCSErrors: 0
    ifHCOutMulticastPkts: 67                              ifHCInMulticastPkts: 67
    ifHCOutBroadcastPckts: 0                              IfHCInBroadcastPkts: 0
    IfHCOutUcastPkts: 0                                   IfHCInUcastPkts: 0
    bcmRxFecCorrectable: 0                                bcmRxFecUncorrectable:
198
    bcmRxRsFecBitError: 542
```

Show Port Map Command

The show port map command displays information about a physical interface's mapping with RtBrick Host port IDs and optic port IDs.

Syntax:

```
show port map
```

Example: Port mapping

```
supervisor@rtbrick>LEAF01: op> show port map
   IFP-Name            Interface-Type      Port-ID   Onlp-Port-ID   Optic-Port-ID
   cpu-0/0/0           cpu                 0         -              -
   ifp-0/0/0           ethernet            1         32             32
   ifp-0/0/1           ethernet            2         33             33
   ifp-0/0/2           ethernet            3         34             34
   ifp-0/0/3           ethernet            4         35             35
   ifp-0/1/1           ethernet            5         1              1
   ifp-0/1/2           ethernet            9         2              2
   ifp-0/1/3           ethernet            13        3              3
   ifp-0/1/4           ethernet            17        4              4
```

```
   ifp-0/1/5           ethernet            21        5              5
   ifp-0/1/6           ethernet            25        6              6
   ifp-0/1/7           ethernet            29        7              7
   ifp-0/1/8           ethernet            33        8              8
   ifp-0/1/9           ethernet            37        9              9
   ifp-0/1/10          ethernet            41        10             10
   ifp-0/1/11          ethernet            45        11             11
   ifp-0/1/12          ethernet            49        12             12
  <...>
```

Show Interface History Command

The show interface history command displays information about the operational status of an interface.

Syntax:

```
show interface history
```

Example: Interface history

```
supervisor@rtbrick.net: cfg> show interface history
Interface           Update Time                       Admin Status    Link Status
Oper Status  Speed
ifp-0/0/3         Tue Apr 15 04:32:49 GMT +0000 2025     Up            Up
Up             -
ifp-0/0/2         Tue Apr 15 04:32:49 GMT +0000 2025     Up            Up
Up             -
ifp-0/0/1         Tue Apr 15 04:32:49 GMT +0000 2025     Up            Up
Up             -
ifp-0/0/0         Tue Apr 15 04:32:49 GMT +0000 2025     Up            Up
Up             -
```

Example: Interface history detail

```
supervisor@rtbrick.net: cfg> show interface history detail
Interface: ifp-0/0/3
  Update Time: Tue Apr 15 04:32:49 GMT +0000 2025
    Admin/Link/Operational status: Up/Up/Up
    Hardware Link Status: Down
    Carrier Transitions: 2
    Holddown: enable
Interface: ifp-0/0/2
  Update Time: Tue Apr 15 04:32:49 GMT +0000 2025
    Admin/Link/Operational status: Up/Up/Up
    Hardware Link Status: Down
    Carrier Transitions: 2
    Holddown: enable
Interface: ifp-0/0/1
  Update Time: Tue Apr 15 04:32:49 GMT +0000 2025
```

```
    Admin/Link/Operational status: Up/Up/Up
    Hardware Link Status: Down
    Carrier Transitions: 2
    Holddown: enable
Interface: ifp-0/0/0
  Update Time: Tue Apr 15 04:32:49 GMT +0000 2025
    Admin/Link/Operational status: Up/Up/Up
    Hardware Link Status: Down
    Carrier Transitions: 2
    Holddown: enable
```

Interface Clear Commands

Clear commands allow to reset operational states.

Interface Statistics

This command clears interface counters.

Syntax:

clear interface statistics <option>

Option	Description
-	Without any additional option, the command clears the counters for all interfaces.
<interface-name>	Clears the counters for the given interface.

API To access the Operational State API that corresponds to this CLI, click here.

Clear Neighbor Interface

This command clears neighbor interface.

Syntax:

clear neighbor <interface-name>

Option	Description
<interface-name>	Clears the given interface.

Example:

```
supervisor@rtbrick.net: cfg> show neighbor
Instance                MAC Address          Interface          IP Address
Dynamic  Entry Time
default                 7a:0e:db:c0:00:00    ifp-0/0/0/10       11.1.1.2
true     Fri May 10 11:00:53
default                 7a:0e:db:c0:00:00    ifp-0/0/0/10
fe80::780e:db00:ac0:0          true     Fri May 10 11:00:09
ip2                     7a:0e:db:c0:00:00    ifp-0/0/0/1        10.1.1.2
true     Fri May 10 11:02:09
ip2                     7a:0e:db:c0:00:00    ifp-0/0/0/1        20.1.1.2
true     Fri May 10 11:00:53
ip2                     11:22:33:44:55:66    ifp-0/0/0/1        25.1.1.1
false    Fri May 10 11:00:02
```

Example:

```
supervisor@rtbrick.net: cfg> clear neighbor interface ifp-0/0/0/1 ip-address
10.1.1.2
Success: cleared neighbors
```

Example:

```
supervisor@rtbrick.net: cfg> show neighbor
Instance                MAC Address          Interface             IP Address
Dynamic  Entry Time
default                 7a:0e:db:c0:00:00    ifp-0/0/0/10       11.1.1.2
true     Fri May 10 11:00:53
default                 7a:0e:db:c0:00:00    ifp-0/0/0/10
fe80::780e:db00:ac0:0             true     Fri May 10 11:00:09
ip2                     7a:0e:db:c0:00:00    ifp-0/0/0/1        20.1.1.2
true     Fri May 10 11:00:53
ip2                     11:22:33:44:55:66    ifp-0/0/0/1        25.1.1.1
false    Fri May 10 11:00:02
```

6.2. ARP/ND

6.2.1. ARP/ND Overview

RBFS allows you to set the timer information for ARP and ND routes. The timer information specifies how frequently a device sends messages to its neighbor. RBFS provides a logical interface with which you can configure timers for neighbor routers. These timers are essential for protocols such as ARP and ND.

RBFS supports timers for the following attributes:

Gratuitous ARP Interval

The Gratuitous ARP is sent as a broadcast by a node to communicate its IP address to MAC address mapping on the network. The GARP timer enables you to specify the interval time based on which GARP can be communicated.

Neighbor Probe Interval

RBFS allows you to configure the neighbor probe interval for the specified interface. This attribute is used to ensure that the neighbor is available or not.

Router Advertisement Interval

RBFS allows you to configure router advertisement interval. Router advertisement includes route information to show the network hosts that the router is operational. The router sends these messages periodically within a time range specified with minimum and maximum values. The Router Advertisement Interval timer applies only to IPv6.

Neighbor Scan Interval

It specifies the time interval for neighbor router scanning. It scans the ARP table of a neighbor router to determine which IP addresses are active.

ARP Throttle Interval

ARP throttling is a method of rate limiting of ARP packets and it safeguards the router by limiting too many ARP requests triggered by incoming traffic. RBFS allows you to configure the time interval for ARP throttling.

```
**Support for Permanent ARP Entry on IFLs**
```

RBFS supports the Permanent ARP Entry on IFLs functionality. This functionality allows devices to continually attempt address resolution for IPv4 or Neighbor Discovery for IPv6 on critical IP addresses within a LAN. The device can dynamically resolve the MAC addresses associated with these specified IPs, even if the GARP is missed from the neighbor.

Supported Platforms

Not all features are necessarily supported on each hardware platform. Refer to the *Platform Guide* for the features and the sub-features that are or are not supported by each platform.

6.2.2. ARP/ND Configuration

Configuration Hierarchy

The diagram illustrates the Neighbor Timer configuration hierarchy.

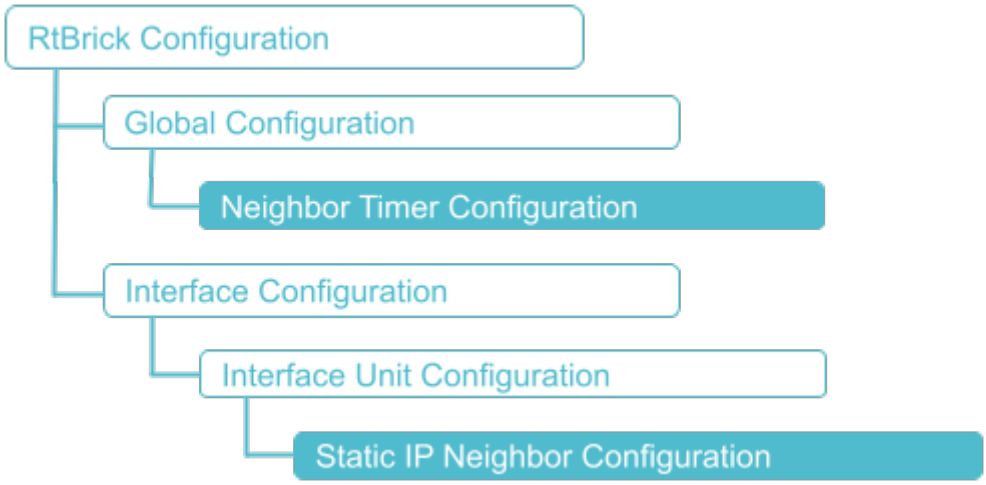


Figure 114. Neighbor Timer Configuration Hierarchy

Configuration Syntax and Commands

Neighbor Timer Configuration

The following sections describe the interface configuration syntax and commands.

Syntax:

```
set global neighbor <attribute> <value>
```

Attribute	Description
garp-interval	Gratuitous ARP interval. The value is in seconds. Range: 1 to 1000 seconds Default: 60
probe-interval	Neighbor probe interval. The value is in seconds. Range: 1 to 1000 seconds Default: 10

Attribute	Description
ra-interval	Router advertisement interval. The value is in seconds. Range: 1 to 1000 seconds Default: 10
scan interval	Neighbor scan interval. The value is in seconds. Range: 1 to 1000 seconds Default: 60
throttle-interval	ARP throttle interval. The value is in seconds. Range: 1 to 1000 seconds Default: 10

Example: Neighbor timer Configuration

```
{
    "rtbrick-config:neighbor": {
      "garp-interval": 10,
      "probe-interval": 120,
      "scan-interval": 120,
      "throttle-interval": 120,
      "ra-interval": 120
    }
  }
```

Static IP Neighbor Configuration

This section describes configuration options at static IP neighbors.

Syntax:

set interface <interface-name> **unit** <unit-id> **neighbor** <attribute> <value>

Attribute	Description
<interface-name>	Name of the interface. Examples: ifp-0/0/1.
<unit-id>	Create a logical interface (also referred to as a sub-interface) under the physical interface.
IPv4/IPv6 <ip-address>	Neighbor IPv4 or IPv6 address.
MAC <mac-address>	Neighbor MAC address.

Example: Static IP Neighbor Configuration

```
supervisor@rtbrick>LEAF01: cfg> show config
{
  "data": {
    "rtbrick-config:interface": [
      {
        "name": "ifp-0/1/5",
        "unit": [
          {
            "unit-id": 1,
            "neighbor": {
              "ipv4": [
                {
                  "address4": "198.51.100.10",
                  "mac": "11:11:11:11:11:11"
                }
              ]
            }
          }
        ]
      }
    ]
  }
}
```

Disabling Gratuitous ARP on Interface

You can disable the sending of Gratuitous ARP (GARP) on an interface, which is enabled by default on all interfaces.



To enable GARP on an interface, you need to delete the garp-disable true configuration.

Syntax:

set interface <interface-name> **unit** <unit-id> **garp-disable true**

Attribute	Description
interface <interface-name>	Name of the interface. Examples: ifp-0/0/1.
garp-disable true	Disables Gratuitous ARP (GARP). Default is GARP enabled.

Example: Disabling Gratuitous ARP

```
supervisor@rtbrick.net: cfg> set interface ifp-0/0/0 unit 100 garp-disable true
```

Enabling Permanent ARP Entry on IFLs

You can enable the Permanent ARP Entry on IFLs functionality.

Syntax:

set interface <interface> **unit** <unit id> **neighbor** < **ipv4 | ipv6** > <ip address> **dynamic true**

Attribute	Description
<interface-name>	Name of the interface. Example: ifp-0/0/1.
<unit-id>	Create a logical interface (also referred to as a sub-interface) under the physical interface.
neighbor IPv4/IPv6 <ip-address>	Neighbor IPv4 or IPv6 address.
dynamic	Dynamic resolution mode.

Example: Enable Permanent ARP Entry on IFLs

```
{
  "ietf-restconf:data": {
    "rtbrick-config:interface": [
      {
        "name": "ifp-0/0/0",
        "host-if": "S1-1-SN",
        "unit": [
          {
            "unit-id": 10,
            "neighbor": {
              "ipv4": [
                {
                  "address4": "10.2.2.2",
                  "dynamic": "true"
                }
              ]
            }
          }
        ]
      },
      {
        "name": "ifp-0/0/1",
        "host-if": "S1-2-SN"
      },
      {
        "name": "ifp-0/0/2",
        "host-if": "S1-3-L1"
      },
```

```
      {
        "name": "ifp-0/0/3",
        "host-if": "S1-4-L1"
      }
    ]
  }
}
```

Host-Path Rate Limiting for Unresolved ARP/ND Traffic

RBFS supports host-path traffic policing for packets generated due to ARP/ND resolution failures for directly connected destinations. When ARP/ND resolution fails, traffic destined for unresolved next hops can be redirected to the control plane, causing excessive host-path load. By default, this feature is enabled with a default policer value of 10Mbps.

Syntax:

set forwarding-options hostpath policer <policer>

Option	Description
<policer>	Name of the policer to be applied to the host path.

The following configuration example attaches a specific policer named 'policer-hostpath' to the hostpath to ensure that management and protocol traffic does not overwhelm the processor during traffic spikes.

```
set forwarding-options hostpath policer policer-hostpath
```

```
{
  "forwarding-options": {
    "hostpath": {
      "policer": {
        "policer-name": policer-hostpath
      }
    }
  }
}
```

6.2.3. ARP/ND Operational Commands

Show Commands

Neighbor Timer Show Commands

Syntax:

show neighbor <option>

Option	Description
-	Without any option, the commands display the information for all neighbors.
instance <instance_name>	Displays summary of the specified neighbor instance
IPv4	Displays neighbor summary for the specified IPv4 address.
IPv6	Displays neighbor summary for the specified IPv6 address.
request <...>	Displays information about GARP requests made.

Example 1: Summary of neighbor

```
supervisor@rtbrick>LEAF01: op> show neighbor
Instance               MAC Address          Interface            IP Address               Dynamic  Entry
Time
default                e4:ed:7a:8e:d5:9d    ifl-0/0/5/1          2001:db8:0:30::
true     Thu Feb 24 02:23:19
```

Example 2: Summary of neighbor instance

```
supervisor@rtbrick>LEAF01: op> show neighbor instance default
Instance               MAC Address          Interface              IP Address
Dynamic  Entry Time
default                7a:01:bf:60:03:02    ifp-0/2/3/10        2001:db8:0:111::
true     Thu Feb 24 04:57:22
default                7a:01:bf:60:03:02    ifp-0/2/3/20        2001:db8:0:19::
true     Thu Feb 24 04:57:22
```

Example 3: Summary of the neighbor for the specified address family

```
supervisor@rtbrick>LEAF01: op> show neighbor ipv4
  <cr>
  instance             Instance name
```

```
supervisor@rtbrick>LEAF01: op> show neighbor ipv6
```

```
Instance              MAC Address          Interface            IP Address               Dynamic  Entry
Time
default               7a:01:bf:60:03:02    ifp-0/2/3/10       2001:db8:0:111::    true     Thu Feb 24
04:57:22
default               7a:01:bf:60:03:02    ifp-0/2/3/20       2001:db8:0:19::     true     Thu Feb 24
04:57:22
```

Example 4: Summary of the static IP neighbor

```
supervisor@rtbrick>LEAF01: op> show neighbor
Instance               MAC Address          Interface             IP Address
Dynamic  Entry Time
default                11:11:11:11:11:11    ifl-0/1/5/1           198.51.100.10
true     Fri Feb 25 10:13:04
```

Neighbor Request

This command is used to display detailed information about various ARP neighbor requests.

Syntax:

show neighbor request <option>

Option	Description
-	Without any option, the commands display the information about all ARP requests made.
type	This option allows you to specify the type of neighbor request.
arp-proxy	Displays information about ARP proxy requests.
arp-reply	Shows ARP reply messages.
arp-request	Displays ARP request messages.
arp-static	Shows static ARP entries.
garp	Displays Gratuitous ARP (GARP) messages.

Example 1: Summary of the request

```
supervisor@rtbrick: cfg> show neighbor request
Interface            IP Address                          Type              Entry
Time
ifl-0/1/10/0         192.168.25.1                        garp              Thu
Aug 22 09:16:12
ifl-0/1/61/10        63.1.1.1                            garp              Thu
Aug 22 09:16:12
```

```
ifl-0/1/61/10        63.1.1.2                          arp-request       Thu
Aug 22 09:18:04
ifl-0/1/61/10        63.1.1.2                          arp-static        Thu
Aug 22 09:16:12
ifl-0/1/10/0         fe80::e8c5:7a00:b2:4aa            garp              Thu
Aug 22 09:16:12
ifl-0/1/61/10        fe80::e8c5:7aff:feb2:4dd          garp              Thu
Aug 22 09:16:12
```

Example 2: Summary of the request type GARP

```
supervisor@rtbrick: cfg> show neighbor request type garp
Interface            IP Address                        Type              Entry Time
ifl-0/1/10/0         192.168.25.1                      garp              Thu Aug 22 09:16:12
ifl-0/1/61/10        63.1.1.1                          garp              Thu Aug 22 09:16:12
ifl-0/1/10/0         fe80::e8c5:7a00:b2:4aa            garp              Thu Aug 22 09:16:12
ifl-0/1/61/10        fe80::e8c5:7aff:feb2:4dd          garp              Thu Aug 22 09:16:12
supervisor@rtbrick: cfg> show neighbor request type arp-static
Interface            IP Address                        Type              Entry Time
ifl-0/1/61/10        63.1.1.2                          arp-static        Thu Aug 22 09:16:12
```

Neighbor History

This command is used to display information for deleted or disconnected neighbors. It allows you to retrieve information for the latest 1,000 deleted neighbor entries.

Syntax:

show neighbor history <option>

Option	Description
-	Without any option, the command displays the history of all neighbors.
instance	Displays the neighbor's history for the specified instance.
interface	Displays history of a specified interface.
ipv4	Displays history of a specified IPv4 neighbor.
ipv6	Displays history of a specified IPv6 neighbor.

Example 1: Neighbor history

```
supervisor@rtbrick: cfg> show neighbor history
Instance    MAC Address       Interface         IP Address
Dynamic     Entry Time         Delete Time
```

```
default     7a:26:ea:c0:00:00 ifl-0/0/2/10   172.10.16.2                 true
Tue Feb 11 06:06:02   Tue Feb 11 06:07:40
default     7a:26:ea:c0:00:00 ifl-0/0/2/10   2001:db8:3::2               true
Tue Feb 11 06:06:02   Tue Feb 11 06:07:40
default     7a:26:ea:c0:00:00 ifl-0/0/2/10   fe80::7826:eaff:fec0:0      true
Tue Feb 11 06:05:31   Tue Feb 11 06:07:40
default     7a:26:ea:c0:00:01 ifl-0/0/3/2    190.100.6.1                 true
Tue Feb 11 06:06:02   Tue Feb 11 06:07:46
default     7a:26:ea:c0:00:01 ifl-0/0/3/2    fe80::7826:eaff:fec0:1      true
Tue Feb 11 06:05:29   Tue Feb 11 06:07:46
```

Example 2: History of a specified nieghbor interface

```
supervisor@rtbrick: cfg> show neighbor history interface ifl-0/0/2/10
Instance     MAC Address        Interface           IP Address
Dynamic  Entry Time        Delete Time
default      7a:26:ea:c0:00:00  ifl-0/0/2/10    172.10.16.2             true
Tue Feb 11 06:06:02  Tue Feb 11 06:07:40
default      7a:26:ea:c0:00:00  ifl-0/0/2/10    2001:db8:3::2           true
Tue Feb 11 06:06:02  Tue Feb 11 06:07:40
default      7a:26:ea:c0:00:00  ifl-0/0/2/10    fe80::7826:eaff:fec0:0  true
Tue Feb 11 06:05:31  Tue Feb 11 06:07:40
```

6.3. ACLs

6.3.1. ACL Overview

ACL Use Cases

In RBFS, Access Control Lists (ACL) serve multiple purposes:

- Provide security by traffic filtering. This applies to both host and transit traffic. ACLs for traffic filtering are user-defined by configuration.
- Redirecting control traffic to the CPU. Such protocol ACLs also referred to as trap rules, are automatically created by the respective protocol, and do not need to be configured.
- Classifying traffic for differentiated QoS treatment. This is a special form of ACL referred to as a multi-field (MF) classifier. For more information about MF classifiers, please refer to the HQoS Configuration Guide.

ACL Components and Processing

User-defined ACLs consist of rules and ordinals. In case of multiple matching ACL rules, you can use priorities to define the result of the ACL.

- Rules - A rule is a named ACL entry that typically contains one or multiple match criteria and an action.
- Ordinals - An ordinal is solely a numbered configuration object. A rule can consist of multiple ordinals. Ordinals help to structure the configuration. In RBFS, it makes no difference if you configure one rule with multiple ordinals or multiple rules with one ordinal each. Please note ordinals do not define the order of processing.
- Scope - ACLs generally apply globally. In particular, they are not applied to interfaces. You can, however configure an interface as a match criteria.
- Priorities - ACL entry priorities are used to define the processing of multiple matching ACL rules. In RBFS, by default, all ACL entries have the same priority, and there is no specific order. For example, if one ACL rule shall permit ICMP traffic from a specific prefix, and another rule shall deny any other ICMP traffic, it will by default result in a conflict as an ICMP packet matches both rules. To ensure that the more specific rule matches first, you can set its priority to higher. When the ACL priority value is set to a lower number, priority is higher.

Prefix Lists

A prefix list is a named list of prefixes. Instead of listing multiple individual prefixes in a match rule of the ACL itself, you can reference a list that contains the prefixes, and thereby apply a common action to all matching prefixes. This helps to maintain lists and reuse them in multiple ACL rules.

Prefix lists can be used in ACL for permitting/denying traffic and in Multifield Classifier (MFC) for classifying traffic. This guide describes how to configure prefix lists and apply them in user-defined ACLs as firewall filters and apply prefix lists in MFC for traffic classification. For more information about applying prefix lists to MF classifiers, please refer to the *HQoS configuration Guide*.

When a prefix list is configured and referenced in an ACL, it is internally first added to an intermediate ACL configuration table. For each prefix, one separate rule is added to the final ACL configuration table. This is different from a prefix match in the ACL rule itself that is directly added to the ACL configuration table. A dedicated range of ordinals (200001-4294967295) is reserved to expand ACL rules when using prefix lists. If configured, the priority will be copied from the prefix list ACL configuration to all the expanded ACL rules.

When using prefix lists, the following restrictions apply:

- You cannot configure the same prefix-list name to match the source prefix list and destination prefix list.
- You cannot configure both the source prefix and source prefix list on the same ACL configuration.
- You cannot configure both the destination prefix and destination prefix list on the same ACL configuration.

Guidelines and Limitations

- ACL and mirror configurations are not supported in virtual deployments.

Supported Platforms

Not all features are necessarily supported on each hardware platform. Refer to the *Platform Guide* for the features and the sub-features that are or are not supported by each platform.

6.3.2. ACL Configuration

For configuring an access control list, you define filter criteria (with match conditions) for the packets and an action for the device to take if the packets match the filtering criteria.

Configuration Hierarchy

The diagram illustrates the ACL configuration hierarchy.

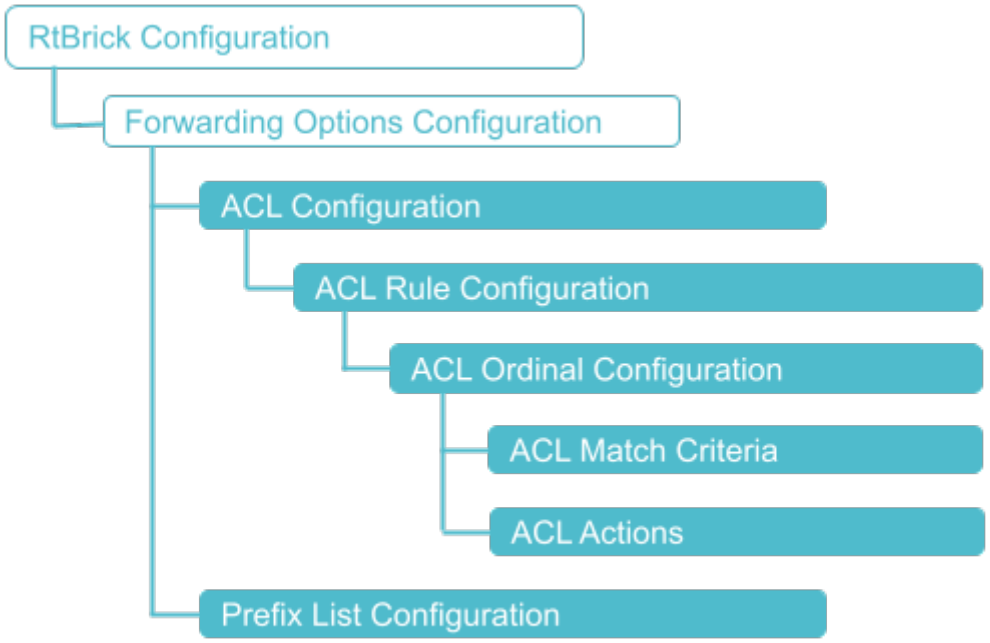


Figure 115. ACL Configuration Hierarchy

Configuration Syntax and Commands

The following sections describe the ACL configuration syntax and commands.

Configuring ACLs

Syntax:

set forwarding-options acl [**l2** | **l3v4** | **l3v6**] **rule** <name> **ordinal** <number> <option> <attribute> <value>

Options	Description
<name>	Name of the ACL rule.
<number>	Specifies the ordinal number.
match <...>	Match configuration hierarchy. Refer to the Configuring ACL Match Criteria section for the ACL match criteria configuration.

Options	Description
action <...>	Action configuration hierarchy. Refer to the Configuring ACL Actions section for the ACL actions configuration.
priority <priority>	Specifies the ACL priority value. The default entry priority for user-defined ACLs changes to 500. The configurable ACL entry priority range is 100 to 20,000. A lower number indicates higher priority.  The user-defined ACL priority range is 100 to 20,000, while BGP FlowSpec priority ranges from 1,501 to 2,500, which prevents conflicts during configuration.

 To access the RESTCONF API that corresponds to this CLI, click here.

Configuring ACL Match Criteria

 The L3V6 ACL with match criteria 'logical interface' is not supported, but the same is supported for L3V4 ACL.

set forwarding-options acl [**l2** | **l3v4** | **l3v6**] **rule** <rulename> **ordinal** <ordinal_value> **match** <attribute> <value>

Attribute	Description
destination-mac <destination-mac>	ACL L2 destination mac match.
destination-ipv4-prefix <destination-ipv4-prefix>	ACL L3 IPv4 destination prefix match.
destination-ipv4-prefix-list <destination-ipv4-prefix-list>	ACL destination IPv4 prefix-list name. You can apply a prefix list that is previously configured. Refer to section Configuring Prefix Lists.
destination-l4-port <destination-l4-port>	ACL L4 destination port match.

Attribute	Description
destination-ipv4-local true	Indicates whether match support is enabled for all traffic destined for the routers' IP addresses. To disable the configuration, use the delete form of the command.
destination-ipv6-prefix <destination-ipv6-prefix>	ACL L3 IPv6 destination prefix match.
destination-ipv6-prefix-list <destination-ipv6-prefix-list>	ACL destination IPv6 prefix-list name. You can apply a prefix list that is previously configured. Refer to section Configuring Prefix Lists.
destination-ipv6-local true	Indicates whether match support is enabled for all traffic destined for the routers' IP addresses. To disable the configuration, use the delete form of the command.
direction ingress	ACL L2/L3 direction match. Currently, only the ingress direction is supported.
ethertype <ethertype>	ACL L2 EtherType match.
inner-tag-protocol-id <inner-tag-protocol-id>	ACL L2 inner TPID match.
inner-vlan <inner-vlan>	ACL L2 inner-VLAN match.
inner-vlan-cfi <inner-vlan-cfi>	ACL L2 inner-VLAN CFI match.
inner-vlan-priority <inner-vlan-priority>	ACL L2 inner-VLAN priority match.
interface <interface>	Interface match.
ip-options true	Match if the IPv4 packet has options. Supported value: true.
ip-protocol <protocol>	ACL IP protocol value match such as TCP, UDP, ICMP.
ipv4-dscp <ipv4-dscp>	IPv4 DSCP value.
ipv4-tos <ipv4-tos>	IPv4 ToS value.
ipv6-tc <ipv6-tc>	Codepoint class value.
logical-interface <logical-interface>	Logical interface match. This is supported only for 'l3v4' ACL.

Attribute	Description
source-ipv4-prefix <source-ipv4-prefix>	ACL L3 IPv4 source prefix match.
source-ipv4-prefix-list <source-ipv4-prefix-list>	ACL source IPv4 prefix-list name. You can apply a prefix list that is previously configured. Refer to section Configuring Prefix Lists.
source-ipv6-prefix <source-ipv6-prefix>	Configure ACL L3 IPv6 source prefix match.
source-ipv6-prefix-list <source-ipv6-prefix-list>	ACL source IPv6 prefix-list name. You can apply a prefix list that is previously configured. Refer to section Configuring Prefix Lists.
source-l4-port <source-l4-port>	ACL L4 source port match.
outer-tag-protocol-id <outer-tag-protocol-id>	ACL L2 outer TPID match.
outer-vlan <outer-vlan>	ACL L2 outer-VLAN match.
outer-vlan-cfi <outer-vlan-cfi>	ACL L2 outer VLAN CFI match.
outer-vlan-priority <outer-vlan-priority>	ACL L2 outer VLAN priority match.
source-mac <source-mac>	ACL L2 source MAC match.
traffic-class <class>	Forward class value. Supported values: class-0 to class-7, class-all.
ttl <ttl>	IPv4 time-to-live value.
match-mpls-traffic true	Match single MPLS label termination. To disable, use the delete form of the command.


To access the RESTCONF API that corresponds to this CLI, click here.

Example 1: Layer 2 Match Configuration

```
{
    "rtbrick-config:acl": {
       "l2": {
          "rule": [
            {
              "rule-name": "a10nsp-drop-lag-2",
```

```
              "ordinal": [
                {
                  "ordinal-value": 1,
                  "match": {
                    "direction": "ingress",
                    "interface": "lag-2",
                    "outer-vlan-priority": 1
                  },
                  "action": {
                    "drop": "true",
                    "statistics": "true"
                  }
                },
```

Example 2: Layer 3 IPv4 Match Configuration

```
{
    "rtbrick-config:acl": {
      "l3v4": {
        "rule": [
          {
            "rule-name": "rtb_firewall_two",
            "ordinal": [
              {
                "ordinal-value": 1000,
                "match": {
                  "direction": "ingress",
                  "source-ipv4-prefix": "198.51.100.50/24",
                  "source-l4-port": 8080
                },
                "action": {
                  "drop": "true"
                }
              }
            ]
          },
          {
            "rule-name": "rule2",
            "ordinal": [
              {
                "ordinal-value": 5,
                "match": {
                  "direction": "ingress",
                  "interface": "ifp-0/0/1"
                }
              }
            ]
          }
        ]
      }
    }
  }
```

Example 3: Layer 3 IPv6 Match Configuration

```
{
```

```
    "rtbrick-config:l3v6": {
      "rule": [
        {
          "rule-name": "rtb_firewall_two",
          "ordinal": [
            {
              "ordinal-value": 1000,
              "match": {
                "direction": "ingress",
                "source-ipv6-prefix": "2001:db8:0:11::/32",
                "source-l4-port": 8080
              },
              "action": {
                "permit": "true"
              }
            }
          ]
        }
      ]
    }
  }
```

Example 4: Match support for all traffic destined for any of the router's IP addresses

```
{
    "rtbrick-config:acl": {
      "l3v4": {
        "rule": [
          {
            "rule-name": "rule4",
            "ordinal": [
              {
                "ordinal-value": 4,
                "match": {
                  "direction": "ingress",
                  "destination-ipv4-local": "true"
                },
                "action": {
                  "drop": "true"
                }
              }
            ]
          }
        ]
      },
      "l3v6": {
        "rule": [
          {
            "rule-name": "rule2",
            "ordinal": [
              {
                "ordinal-value": 2,
                "match": {
                  "direction": "ingress",
                  "destination-ipv6-local": "true"
                },
                "action": {
```

```
                "drop": "true"
              }
            }
          ]
        }
      ]
    }
  }
}
```

Configuring ACL Actions

Syntax:

set forwarding-options acl [**l3v4** | **l3v6**] **rule** <rulename> **ordinal** <ordinal_value> **action** <attribute> <value>

Attribute	Description
drop true	If the ACL rule specifies drop true, the system will discard any packets that match that rule. Use the delete form of the command for the system to ignore the rule.
permit true	If the ACL rule specifies permit true, the system forwards traffic matching that rule. Use the delete form of the command for the system to ignore the rule.
action statistics true	Configure action, enable statistics. Use the delete form of the command to disable the configuration.  A limited number of counter resources are available in a common pool for user-defined ACLs, protocol ACLs, L3, and L2X logical interfaces.
forward-class <class>	Specifies forward class value (class-0 to class-7, class-all)
mirror <mirror>	Specifies ACL action mirror name.  Currently, ACLs with mirror actions are not supported.

Attribute	Description
capture true	You can enable the capture action when using the RBFS built-in capture feature with an ACL to more granularly specify the traffic to be captured. To disable, use the delete form of the command. NOTE: For more information and an example, refer to the *RBFS NOC Troubleshooting Guide*.
policer-name <policer-name>	Specifies policer profile name.
redirect-to-cpu true	Configure action, redirect packets to CPU. To disable, use the delete form of the command.
action traffic-sample true	Allows you to sample traffic that matches specific ACL rules and mirror it to the CPU for analysis.
trap default	Allows the system to trap matching packets to the control plane and process them.

API To access the RESTCONF API that corresponds to this CLI, click here.

Example 1: ACL Rule with Drop Action

```
{
            "rule-name": "rtb_firewall_two",
            "ordinal": [
              {
                "ordinal-value": 1000,
                "match": {
                  "direction": "ingress",
                  "source-ipv4-prefix": "198.51.100.50/24",
                  "source-l4-port": 8080
                },
                "action": {
                  "drop": "true"
                }
              }
            ]
          }
```

Example 2: ACL-based Traffic Sampling

```
set forwarding-options acl l3v4 rule sample-icmp ordinal 100 action traffic-sample
true
```

```
{
  "forwarding-options": {
    "acl": {
      "l3v4": {
        "rule": [
          {
            "name": "sample-icmp",
            "ordinal": 100,
            "action": {
              "traffic-sample": true
            }
          }
        ]
      }
    }
  }
}
```



After the ACL is configured with the traffic-sample action, you can use the capture interface <intf_name> CLI to monitor traffic that matches the specified ACL.

Configuring Prefix Lists

Configuring IPv4/IPv6 Prefix List for ACL and Multifield Classifier

Syntax:

set forwarding-options prefix-list <prefix-list-name> <attribute> <value>

Attribute	Description
<prefix-list-name>	Name of the prefix list, which will be later used to attach with ACL configuration.
ipv4-prefix <ipv4_prefix>	Specifies the IPv4 prefix address.
ipv6-prefix <ipv6_prefix>	Specifies the IPv6 prefix address.



To access the RESTCONF API that corresponds to this CLI, click here.

Example 1: Prefix List Configuration

```
supervisor@rtbrick>LEAF01: op> show config forwarding-options prefix-list
{
    "rtbrick-config:prefix-list": [
      {
```

```
        "prefix-list-name": "ipv4-list",
        "ipv4-prefix": [
          {
            "ipv4-prefix": "198.51.100.50/24"
          },
          {
            "ipv4-prefix": "198.51.101.60/24"
          },
          {
            "ipv4-prefix": "198.51.102.70/24"
          }
        ]
      }
    ]
  }
```

Example 2: Using Prefix-list in Multifield-Classifier

```
supervisor@rtbrick>LEAF01: op> show config forwarding-options prefix-list pta-
iptv-multicast
{
  "rtbrick-config:prefix-list": [
    {
      "prefix-list-name": "ipv4-list",
      "ipv4-prefix": [
          {
            "ipv4-prefix": "198.51.100.50/24"
          },
          {
            "ipv4-prefix": "198.51.101.60/24"
          },
          {
            "ipv4-prefix": "198.51.102.70/24"
          }
      ]
    }
  ]
}
```

Example 3: Viewing Multifield-Classifier Details

```
supervisor@rtbrick>LEAF01: op> show config forwarding-options class-of-service
multifield-classifier acl l3v4 rule pta-triple-play-8queues ordinal 6000
{
  "rtbrick-config:ordinal": [
    {
      "ordinal-value": 6000,
      "match": {
        "destination-ipv4-prefix-list": "ipv4-list"
      },
      "action": {
        "forward-class": "class-1",
        "remark-codepoint": 248
      }
    }
```

```
  ]
}
```

6.3.3. ACL Operational Commands

ACL Show Commands

Syntax:

show acl <option>

Option	Description
-	Without any option, this command displays brief information about the access control list (ACL).
detail	Displays detailed information about the access-control list (ACL).
type <acl_type>	Displays detailed information for the specified ACL type.
rule <acl-rule-name>	Displays detailed information for the specified ACL rule name.
ordinal <ordinal>	Displays detailed information for the specified Ordinal.
type <acl_type> rule <rule_name>	Displays detailed information for the specified ACL Type and Rule name.
type <acl_type> ordinal <ordinal>	Displays detailed information for the specified ACL Type and Ordinal.
rule <rule_name> type <acl_type>	Displays detailed information for the specified ACL Type and Rule name.
rule <rule_name> ordinal <ordinal>	Displays detailed information for the specified Rule name and Ordinal.
ordinal <ordinal> type <acl_type>	Displays detailed information for the specified ACL type and ordinal.
ordinal <ordinal> rule <rule_name>	Displays detailed information for the specified rule name and ordinal.

Option	Description
type <acl_type> rule <rule_name> ordinal <ordinal>	Displays detailed information for the specified Ordinal, ACL type and rule name.
type <acl_type> ordinal <ordinal> rule <rule_name>	Displays detailed information for the specified Ordinal, ACL type and rule name.
rule <rule_name> ordinal <ordinal> type <acl_type>	Displays detailed information for the specified Ordinal, ACL type and rule name.
rule <rule_name> type <acl_type> ordinal <ordinal>	Displays detailed information for the specified Ordinal, ACL type and rule name.
ordinal <ordinal> rule <rule_name> type <acl_type>	Displays detailed information for the specified Ordinal, ACL type and rule name.
ordinal <ordinal> type <acl_type> rule <rule_name>	Displays detailed information for the specified Ordinal, ACL type and rule name.

Example 1: Show information about ACLs

```
supervisor@rtbrick.net: op> show acl
ACL                          Ordinal  Type           Attach Point   Priority
Policer Name
lldp.ifp-0/0/21.trap.rule          0  l2             ifp-0/0/21           50
_DEFAULT_POLICER_LLDP_GLOBAL_10MB
lldp.ifp-0/0/21.trap.rule          1  l2             ifp-0/0/21           50
_DEFAULT_POLICER_LLDP_GLOBAL_10MB
lldp.ifp-0/0/21.trap.rule          2  l2             ifp-0/0/21           50
_DEFAULT_POLICER_LLDP_GLOBAL_10MB
BNG_RADIUS-v4-auth-trap            -  l3v4           -                    50
_DEFAULT_POLICER_20_MB
MFC_GLOBAL_TRAFFIC               102  multifield_ipv4-                   500   -
lldp.ifp-0/0/4.trap.rule           0  l2             ifp-0/0/4            50
_DEFAULT_POLICER_LLDP_GLOBAL_10MB
lldp.ifp-0/0/4.trap.rule           1  l2             ifp-0/0/4            50
_DEFAULT_POLICER_LLDP_GLOBAL_10MB
```

Example 2: Show detailed information about ACLs

```
supervisor@rtbrick>LEAF01: op> show acl detail
Rule: rule4
  ACL type: l3v4
```

```
  Ordinal: 4
    Match:
      Direction: ingress
      Source IPv4 prefix: 198.51.100.35/24
    Action:
      Drop: True
    Result:
      Trap ID: User Defined
    Statistics:
      Units      Total       Accepted    Dropped
      Packets    4           0           4
      Bytes      424         0           424
  Ordinal: 8
    Match:
      Direction: ingress
      Source IPv4 prefix: 198.51.100.45/24
    Action:
      Drop: True
    Result:
      Trap ID: User Defined
    Statistics:
      Units      Total       Accepted    Dropped
      Packets    9           0           9
      Bytes      990         0           990
Rule: lldp.ifp-0/0/0.trap.rule
  ACL type: l2
  Ordinal: -
    Match:
      Attachment point: ifp-0/0/0
      Direction: ingress
      Destination MAC: 01:80:c2:00:00:0e
    Action:
      Redirect to CPU: True
    Result:
      Trap ID: LLDP
    Statistics:
      Units      Total       Accepted    Dropped
      Packets    105         105         0
      Bytes      12915       12915       0
Rule: lldp.ifp-0/1/0.trap.rule
  ACL type: l2
  Ordinal: -
    Match:
      Attachment point: ifp-0/1/0
      Direction: ingress
      Destination MAC: 01:80:c2:00:00:0e
    Action:
      Redirect to CPU: True
    Result:
      Trap ID: LLDP
    Statistics:
      Units      Total       Accepted    Dropped
      Packets    220         220         0
      Bytes      19140       19140       0
```

Example 3: Show detailed information for a specified ACL Rule

```
supervisor@rtbrick.net: op> show acl rule trap_icmp
Rule: trap_icmp
```

```
  ACL type: ext_l3v4
  Ordinal: 100           Priority: 500
    Match:
      Direction: external
    Action:
    Result:
      Trap ID: user-defined
      ACL Handle: 1
      External:
        Value: 29
          Is Trap ID: Yes
          Trap ID: 14
          Trap Strength: 0
          Is QoS: No
          Class: 0
          Policer ID: 0
```

Example 4: Show detailed information for a specified ACL Rule with ACL direction as external and ACL type as ext_multifield_ipv4.

```
supervisor@rtbrick.net: op> show acl rule global_mfc ordinal 104
Rule: global_mfc
  ACL type: ext_multifield_ipv4
  Ordinal: 104           Priority: 500
    Match:
      Direction: external
      Source IPv4 prefix: 131.0.0.2/32
      IP TOS: 32
    Action:
    Result:
      ACL Handle: 4
       External:
         Value: 3
           Class: 3
           Is Remark: No
           ECN: 0
           Remark Codepoint: 0
```

ACL Statistics Commands



ACL statistics are currently not supported for PIM, IGMP, and L2TP protocol traffic.

Syntax:

show acl <option> **statistics**

Option	Description
statistics	Displays ACL statistics information
<acl-name> statistics	Displays ACL statistics information for the specified ACL.
type <acl_type> statistics	Displays ACL statistics information for the specified ACL type.
rule <rule_name> statistics	Displays ACL statistics information for the specified rule name.
ordinal <ordinal> statistics	Displays ACL statistics information for the specified ordinal.
type <acl_type> rule <rule_name> statistics	Displays ACL statistics information for the specified ACL type and rule name.
type <acl_type> ordinal <ordinal> statistics	Displays ACL statistics information for the specified ACL type and ordinal.
rule <rule_name> type <acl_type> statistics	Displays ACL statistics information for the specified ACL type and rule name.
rule <rule_name> ordinal <ordinal> statistics	Displays ACL statistics information for the specified rule name and ordinal.
ordinal <ordinal> type <acl_type> statistics	Displays ACL statistics information for the specified ACL type and ordinal.
ordinal <ordinal> rule <rule_name> statistics	Displays ACL statistics information for the specified rule name and ordinal.
<acl_type> rule <rule_name> ordinal <ordinal> statistics	Displays ACL statistics information for the specified ordinal, ACL type and rule name.
type <acl_type> ordinal <ordinal> rule <rule_name> statistics	Displays ACL statistics information for the specified ordinal, ACL type and rule name.
rule <rule_name> ordinal <ordinal> type <acl_type> statistics	Displays ACL statistics information for the specified ordinal, ACL type and rule name.
rule <rule_name> type <acl_type> ordinal <ordinal> statistics	Displays ACL statistics information for the specified ordinal, ACL type and rule name.

Option	Description
ordinal <ordinal> rule <rule_name> type <acl_type> statistics	Displays ACL statistics information for the specified ordinal, ACL type and rule name.
ordinal <ordinal> type <acl_type> rule <rule_name> statistics	Displays ACL statistics information for the specified ordinal, ACL type and rule name.

Example 1: Display ACL statistics information

```
supervisor@rtbrick>LEAF01: op> show acl statistics
ACL                             Units      Total       Accepted    Dropped
rule4                           Packets    4           0           4
                                Bytes      424         0           424
rule4                           Packets    9           0           9
                                Bytes      990         0           990
lldp.ifp-0/0/0.trap.rule        Packets    107         107         0
                                Bytes      13161       13161       0
lldp.ifp-0/1/0.trap.rule        Packets    221         221         0
                                Bytes      19227       19227       0
lldp.ifp-0/1/1.trap.rule        Packets    221         221         0
                                Bytes      19227       19227       0
lldp.ifp-0/1/4.trap.rule        Packets    214         214         0
                                Bytes      31672       31672       0
lldp.ifp-0/1/5.trap.rule        Packets    214         214         0
                                Bytes      31672       31672       0
lldp.ifp-0/1/6.trap.rule        Packets    214         214         0
                                Bytes      31672       31672       0
lldp.ifp-0/1/12.trap.rule       Packets    107         107         0
                                Bytes      13375       13375       0
lldp.ifp-0/1/13.trap.rule       Packets    107         107         0
                                Bytes      13375       13375       0
lldp.ifp-0/1/22.trap.rule       Packets    107         107         0
                                Bytes      13375       13375       0
lldp.ifp-0/1/23.trap.rule       Packets    107         107         0
                                Bytes      13375       13375       0
```

Example 2: Display ACL statistics information for the specified ACL

```
supervisor@rtbrick>LEAF01: op> show acl rule4 statistics
ACL          Units      Total       Accepted    Dropped
rule4        Packets    4           0           4
             Bytes      424         0           424
rule4        Packets    9           0           9
             Bytes      990         0           990
```

Show Trap Commands

A trap refers to a mechanism where specific packets or traffic conditions are intercepted (or “trapped”) by the system—typically from the data plane to the control plane—for further processing. It provides visibility into how traffic is handled by the system. It includes both forwarded and dropped packet statistics, helping operators analyze traffic behavior to identify anomalies.

Syntax:

show trap <option>

Option	Description
trap_name	Specifies the name of the trap. Displays detailed information about a specific trap, including its configuration, state, and associated parameters.
statistics	Displays statistical information for all traps, such as the number of traps generated, sent, or failed.

Example for trap statistics of RPF.

```
supervisor@rtbrick.net: cfg> show trap statistics rpf
Trap Statistics Type: rpf
    Statistics ID: 1
    Counters:
        Forward-Packets: 0
        Forward-Bytes: 0
        Drop-Packets: 1550
        Drop-Bytes: 2194800
```

Example for trap statistics of NAT.

```
supervisor@rtbrick.net: cfg> show trap statistics nat
Trap Statistics Type: nat
    Statistics ID: 524
    Counters:
        Forward-Packets: 20943738
        Forward-Bytes: 29405223462
        Drop-Packets: 38998908
        Drop-Bytes: 54754548576
```

ACL Clear Commands

Clear commands allow resetting operational states.

Clear ACL Statistics

Syntax:

clear acl <options>

Option	Description
statistics	Clears all the ACL statistics.
type <acl_type> statistics	Clears all ACL statistics for the specified ACL type
rule <rule_name> statistics	Clears all ACL statistics for the specified rule
ordinal <ordinal> statistics	Clears all ACL statistics for the specified ordinal
type <acl_type> rule <rule_name> statistics	Clears all ACL statistics for the specified ACL type and rule
type <acl_type> ordinal <ordinal> statistics	Clears all ACL statistics for the specified ACL type and ordinal
rule <rule_name> type <acl_type> statistics	Clears all ACL statistics for the specified ACL type and rule
rule <rule_name> ordinal <ordinal> statistics	Clears all ACL statistics for the specified rule and ordinal
ordinal <ordinal> type <acl_type> statistics	Clears all ACL statistics for the specified ACL Type and Ordinal
ordinal <ordinal> rule <rule_name> statistics	Clears all ACL statistics for the specified Rule name and Ordinal
type <acl_type> rule <rule_name> ordinal <ordinal> statistics	Clears all ACL statistics for the specified Ordinal, ACL Type and Rule name
type <acl_type> ordinal <ordinal> rule <rule_name> statistics	Clears all ACL statistics for the specified Ordinal, ACL Type and Rule name

Option	Description
rule <rule_name> ordinal <ordinal> type <acl_type> statistics	Clears all ACL statistics for the specified Ordinal, ACL Type and Rule name
rule <rule_name> type <acl_type> ordinal <ordinal> statistics	Clears all ACL statistics for the specified Ordinal, ACL Type and Rule name
ordinal <ordinal> rule <rule_name> type <acl_type> statistics	Clears all ACL statistics for the specified Ordinal, ACL Type and Rule name
ordinal <ordinal> type <acl_type> rule <rule_name> statistics	Clears all ACL statistics for the specified Ordinal, ACL Type and Rule name

Example: Clearing ACL Statistics of a specified ACL Rule

```
supervisor@rtbrick>LEAF01: op> clear acl rule lldp.ifp-0/0/44.trap.rule statistics
Success : command success
supervisor@rtbrick>LEAF01: op>
```

Clear Trap Statistics

This command clears the accumulated statistics for all traps.

Syntax:

clear trap statistics

Example:

```
clear trap statistics rpf
```

```
supervisor@rtbrick.net: cfg> clear trap statistics rpf
Success : command success
```

6.4. Port Mirroring

6.4.1. Port Mirroring Overview

Port Mirroring is a method of monitoring network traffic. When you enable port mirroring, the switch sends a copy of all network packets seen on one port to another port, where the packet can be analyzed.

Inbound Mirroring

Inbound mirroring is defined per In-Port, or per In-Port x VLAN. Configurations for six distinct VLAN tags, for any other VLAN tag, and for packets without VLAN tags are supported. The ingress mirroring can be sampled by specifying a probability that a matching packet will be mirrored.

Outbound Mirroring

Outbound mirroring is defined per Out-Port, or per Out-Port x VLAN tag. Configurations for seven distinct VLAN tags are supported.



Only configure one, either the IFL or the IFP, as the mirror source interface. Do not configure both a source IFL and a source IFP for the same mirror as it causes hardware failure.

Guidelines and Limitations

- Up to 15 mirror profiles can be configured.
- The same mirror resources are used for Lawful Interception (LI) and Port Mirroring.
- You can configure a CPU port as destination physical interface port; but if heavy traffic is mirrored, it may impact system performance.
- If physical interface/logical interface goes down, mirror configuration will not be deleted automatically. You need to delete the mirror configuration explicitly.
- Before creating logical interface mirroring, the source logical interface should exist.
- The logical interface should not be deleted during mirroring.

- If you want to mirror traffic to CPU, enable the control plane security features. For more refer, see the *Control Plane Security Guide*.
- Since this is a debugging tool, the save and reload functionality is not supported.

Supported Platforms

Not all features are necessarily supported on each hardware platform. Refer to the *Platform Guide* for the features and the sub-features that are or are not supported by each platform.

6.4.2. Port Mirroring Configuration

Configuration Hierarchy

The diagram illustrates the port mirroring configuration hierarchy.



Figure 116. Port Mirroring Configuration Hierarchy

Configuration Syntax and Commands

The following sections describe the port mirroring configuration syntax and commands.

Syntax:

```
set forwarding-options mirror <name> [source | destination] <attribute> <value>
```

Attribute	Value
<name>	Name for mirror configuration

Attribute	Value
acl true	Configure source as ACL.  Use delete form of the command to disable the configuration.
direction [egress | ingress]	Configure traffic direction ingress/egress.
interface <interface>	Specifies the physical interface name.
logical-interface <logical-interface>	Configure source logical interface name.

Example 1: Mirroring one physical interface traffic to another physical interface

```
{
    "rtbrick-config:mirror": [
      {
        "name": "MIRROR1",
        "destination": {
          "interface": "ifp-0/0/4"
        },
        "source": {
          "direction": "ingress",
          "interface": "ifp-0/0/2"
        }
      }
    ]
  }
```

Example 2: Mirroring Traffic to CPU

```
{
    "rtbrick-config:mirror": [
      {
        "name": "mirror1",
        "destination": {
          "interface": "cpu-0/0/200"
        },
        "source": {
          "direction": "ingress",
          "interface": "ifp-0/0/52"
        }
      }
    ]
  }
```

6.4.3. Port Mirroring Operational Commands

Capturing Mirror Traffic

After you configure mirroring to CPU by using the commands above, you can use the **capture** command to capture the mirror traffic.

Syntax:

capture mirror file <file_name> [**start** | **stop**]

Attribute	Value
<file_name>	Name of the file where mirror traffic is captured

Example 1: Starting and stopping mirror traffic to a file

```
root@rtbrick: cfg> capture mirror file test.pcap start
root@rtbrick: cfg> capture mirror file test.pcap stop
```

Show Commands

show capture sessions

Syntax:

show capture sessions

Option	Description
-	Without any option, the commands displays the FIB packet Capture sessions.

Example 1: Summary of FIB packet Capture sessions

```
supervisor@rtbrick: op> show capture sessions
Interface                     Direction   File                          Context
ifp-0/0/1                     BOTH        -                             45
```

6.5. LAG

6.5.1. LAG Overview

A link aggregation group (LAG) combines multiple physical links into a single logical interface which is referred to as a bundle interface. These physical links are connected between two devices. The device uses LACP protocol to bundle the member links and create high speed connections. Although a bundle can be created based on static configuration, bandwidth can be increased by adding member links to the bundle. This also allows load sharing among the physical links. Thus, a group of ports combined together is called a link aggregation group, or LAG.

The LAG interface combines the bandwidth of the individual member links. The properties like speed and bandwidth of the individual member links should be the same to make it part of that LAG. The traffic which is directed towards the LAG interface is sent on the individual member links. This traffic is not pinned to a specific member link but rather determined by a specific flow. This hash could be calculated based on various fields in the packet.

LAG Interface Modes

The LAG interface could be formed statically or dynamically. LACP protocol helps to bring up the interface dynamically. The two modes of LAG interface are:

1. **Static LAG**: In this mode, the member links do not initiate or process any of the LACP packets received. The device brings up the LAG interface without LACP negotiation.
2. **Dynamic LAG**: In this mode, the member links process the LACP packets received. Under this mode, there two sub modes:
    a. **active**: LACP packets are generated on each of the member links on the transmit side.
    b. **passive**: LACP packets are generated on the member link in response to the LACP packet received. That means, at least one side of the LAG should be configured as active to bring up the LAG interface.

Layer2 and Layer 3 Interfaces

LAG interfaces can be used as layer 2 and layer 3 interfaces. A regular layer 2 or layer 3 interface can be created on top of the single LAG interface. These interfaces can be divided based on 802.1q VLAN ID's. Multiple layer 3 interfaces can be created and each of them can be associated with different instances.

LACP (Link Aggregation Control Protocol)

LACP is part of an IEEE specification (802.3ad) that allows several physical ports to be grouped to form a single logical interface. LACP allows a switch to negotiate an LAG by sending LACP packets on its member links. It negotiates the various configuration parameters to bring up the individual member links.

Interface Holddown

The Interface Holddown feature remains supported when interfaces are grouped in a LAG. For more information about the Interface Holddown feature, see Interface Holddown.

Guidelines and Limitations

- You cannot configure logical interfaces on a LAG member ports.
- You cannot configure L2X on a LAG member port.

LAG Hashing Algorithm

The LAG hashing algorithm distributes traffic across multiple paths or links for load balancing. It achieves this by using various packet header fields (like IP addresses, port numbers, or MAC addresses) to generate a hash value, ensuring probability and an equitable distribution of network traffic.

The following table lists the packet header fields that are used by the LAG hashing algorithm to generate a hash value, which in turn determines how traffic is distributed. A tick ( ) indicates that the field is used by the hashing algorithm. A cross mark ( ) indicates that the field is not used by the hashing algorithm.

IPv4 UDP/TCP

The following table lists the header fields used in the LAG hashing algorithm for

different platforms when handling IPv4 UDP/TCP traffic.

Header Field	UfiSpace S9600-102XC	UfiSpace S9600-72XC	UfiSpace S9600-32X	UfiSpace S9510-28DC	UfiSpace S9500-22XST	Edgecore AGR420	Edgecore AGR400	Edgecore CSR440
Source IP Address (SIP)								
Destination IP Address (DIP)								
Protocol								
Source Port								
Destination Port								

IPv4

The following table lists the header fields used in the LAG hashing algorithm for different platforms when handling IPv4 traffic.

Header Field	UfiSpace S9600-102XC	UfiSpace S9600-72XC	UfiSpace S9600-32X	UfiSpace S9510-28DC	UfiSpace S9500-22XST	Edgecore AGR420	Edgecore AGR400	Edgecore CSR440
Source IP Address (SIP)								
Destination IP Address (DIP)								
Protocol								

IPv6 UDP/TCP

The following table lists the header fields used in the LAG hashing algorithm for different platforms when handling IPv6 UDP/TCP traffic.

Header Field	UfiSpace S9600-102XC	UfiSpace S9600-72XC	UfiSpace S9600-32X	UfiSpace S9510-28DC	UfiSpace S9500-22XST	Edgecore AGR420	Edgecore AGR400	Edgecore CSR440
Source IP Address (SIP)								
Destination IP Address (DIP)								
Next Header								
Source Port								
Destination Port								
Flow Label (FL)								

IPv6

The following table lists the header fields used in the LAG hashing algorithm for different platforms when handling IPv6 traffic.

Header Field	UfiSpace S9600-102XC	UfiSpace S9600-72XC	UfiSpace S9600-32X	UfiSpace S9510-28DC	UfiSpace S9500-22XST	Edgecore AGR420	Edgecore AGR400	Edgecore CSR440
Source IP Address (SIP)								
Destination IP Address (DIP)								
Next Header								
Flow Label (FL)								

Ethernet (L2 Forwarding)

The following table lists the header fields used in the LAG hashing algorithm for different platforms when handling Ethernet (L2 Forwarding) traffic.

Header Field	UfiSpace S9600-102XC	UfiSpace S9600-72XC	UfiSpace S9600-32X	UfiSpace S9510-28DC	UfiSpace S9500-22XST	Edgecore AGR420	Edgecore AGR400	Edgecore CSR440
Source MAC								
Destination MAC								
EtherType								
VLAN								

MPLS

The following table lists the header fields used in the LAG hashing algorithm for different platforms when handling MPLS traffic.

Header Field	UfiSpace S9600-102XC	UfiSpace S9600-72XC	UfiSpace S9600-32X	UfiSpace S9510-28DC	UfiSpace S9500-22XST	Edgecore AGR420	Edgecore AGR400	Edgecore CSR440
All MPLS Labels								

Field Definitions

SIP/DIP (Source/Destination IP Address)

Identifies the source/destination of the packet, that is, IPv4/IPv6

Next Header/Protocol

Identifies the type of payload, such as TCP, UDP etc.

L4 Ports (Source/Destination Port)

Used in TCP/UDP headers to identify application endpoints

FL (Flow Label)

Used for IPv6 to improve load balancing

MAC Addresses (Source/Destination MAC)

Used in Ethernet frames for identifying source and destination devices

EtherType

Indicates the protocol encapsulated in the Ethernet frame

VLAN

Identifies the VLAN to which the frame belongs

MPLS Labels

Used in MPLS networks to identify the destination / Forward Equivalence Class for packet forwarding

Supported Platforms

Not all features are necessarily supported on each hardware platform. Refer to the *Platform Guide* for the features and the sub-features that are or are not supported by each platform.

Supported Number of LAG Interfaces on Platforms

For information on the maximum number of LAG interfaces and members per LAG supported on each hardware platform, refer to the Supported Platforms section of the *Platform Guide*.

6.5.2. LAG Configuration

Creating LAG Interfaces

Syntax:

set link-aggregation interface <name> <attribute> <value>

Attribute	Description
<name>	Specifies the name of the LAG interface. The supported LAG interface names: 'lag-1' to 'lag-99'.
<description>	Link aggregation interface description

Attribute	Description
mode <mode>	Specifies the LAG mode. The default mode is LACP. The possible modes are: • lacp - In this mode, the member links processes LACP packets received. When you create a LAG interface in LACP mode, the LACP PDUs are sent and received through member interfaces. • static: In this mode, the member links do not initiate or process any of the LACP packets received.
<minimum-link-count>	Specify the minimum number of active member links required for the link aggregation interface.
<member-interface>	Specify name of the member interface.
redundancy-session-id	Specify the value for the redundancy group session ID. Range from 1 to 65535 is allowed.
system-id	Specify the MAC address (as system ID) of the device for the link-aggregation interface.



redundancy-session-id, and system-id attributes can only be used when you deploy RBFS in redundancy mode. For information about LAG configuration when deploying RBFS in redundancy mode, see RBFS Redundancy Solution Guide.

Example: LAG Interfaces Configuration

```
supervisor@rtbrick: cfg> show config link-aggregation
{
    "rtbrick-config:link-aggregation": {
      "interface": [
        {
          "interface-name": "lag-3",
          "mode": "lacp",
          "minimum-link-count": 2,
          "member-interface": [
            {
              "member-interface-name": "ifp-0/0/1",
              "lacp-mode": "active"
            },
            {
              "member-interface-name": "ifp-0/0/5",
              "lacp-mode": "active"
            }
            {
```

```
            "member-interface-name": "ifp-0/0/5",
            "lacp-mode": "passive"
          }
        ]
      }
    ]
  }
}
```

To access the RESTCONF API that corresponds to this CLI, click here.

Configuring LAG Member Interfaces

You can add member ports to the LAG interface. The command below allows you to bundle multiple physical interfaces with similar properties like speed, MTU, MRU.

Syntax:

set link-aggregation interface <name> **member-interface** <name> <attribute> <value>

Attribute	Description
lacp-mode <mode>	Specifies the LACP mode. The default lacp-mode is active. **active**: LACP packets are generated on each of the member links on the trad, the receive side. **passive**: LACP packets are generated on the member link in response to the LACP packet received at one side of the LAG should be configured as active to bring the LAG interface.

Attribute	Description
lacp-timeout <timeout-value>	Specifies the timeout for the LACP session. A long timeout is 90 seconds, while a short is 3 seconds (default is short). Setting the timeout value will instruct the partner at which interval it should send the updates (30 seconds for long timeout, 1 second for short timeout).  Having mismatching timeouts will not break the operation, even though it is not desirable design-wise. This is because in LACP both Actor and Partner negotiate the transmission rate, so the transmitter sends at the receiver's expected interval.

Configuring QoS on LAG Interface

RBFS supports QoS at physical interface level for LAG. Users can apply QoS profile at physical interface level through which one common QoS classification can be applied for all traffic on that port, irrespective of the destination logical interface.

The following features are supported:

- Classification (IEEE-802.1)
- Remarking (IEEE-802.1)
- Ingress Policing
- Egress Policing

For information about configuring the above features, refer the *HQoS Configuration Guide*.



- You cannot apply QoS class of service on LAG logical interface
- Currently, queuing and scheduling are not supported

Syntax:

set interface <physical interface> **class-of-service** <class-of-service>

Attribute	Description
<interface>	Name of the interface
<class-of-service>	Specifies the class of service

Example:

```
supervisor@rtbrick: cfg> set interface lag-11 class-of-service Retail_profile
supervisor@rtbrick: cfg> commit
supervisor@rtbrick: cfg> show config int lag-11
{
    "rtbrick-config:interface": [
      {
        "name": "lag-11",
        "class-of-service": "Retail_profile"
      }
    ]
  }
```

Configuring L2X on LAG Interface

All forms of L2X that are supported on the regular physical interfaces are supported on LAG. The incoming packet is be matched to a specific L2X profile based on the Cross Connect configuration on the specified LAG interface.

The following match conditions are supported on the LAG interface:

- Incoming LAG interface without any VLAN
- Incoming LAG interface with a single VLAN
- Incoming LAG interface with inner and Outer VLAN
- Incoming LAG interface with any single VLAN
- Incoming LAG interface with inner VLAN and any outer VLAN

For information about configuring L2X, see the L2X Configuration Guide.

The following table provides the L2X match action attributes which are supported on LAG interface.

Attribute	Description
nexthop6 <nexthop>	Next-Hop address
match-type <match-type>	Match types with which traffic can be matched.
service-label <service_label>	Service label value. NOTE: Supported MPLS label values are 0 - 1048575. The reserved MPLS label range is 0 - 15. In RBFS, BGP uses the label range 20000 - 100000. It is recommended to assign label values outside of these reserved ranges to avoid conflicts.
ingress-vlan-operation <ingress-vlan-action>	VLAN operation on ingress side outer VLAN
ingress-outer-vlan <vlan-id>	Outer VLAN at ingress side
outgoing_ifp	Outgoing interface
vlan_operation	VLAN operation
outgoing_outer_vlan1	Outgoing outer VLAN

Configuring Holddown on LAG Interface

By default, the Interface Hold-down feature is enabled. You can disable the feature if you want. It is allowed to configure timer value for options such as 'holddown down delay' and 'holddown up delay'.

Syntax:

set interface <interface-name> <attribute> <value>

Attribute	Description
<interface-name>	Name of the lag. Example: lag-1.
holddown <disable|enable>	Enable or disable the holddown timer feature. By default, the feature is enabled.
holddown-down-delay	Configure the down delay time in milliseconds (ms). The allowed values include 0, 100, 200, 500, 1000, 2000, 5000, and 10000. It overrides the default delay of '0' milliseconds.

Attribute	Description
holddown-up-delay	Configure the up delay time milliseconds (ms). The allowed values include 0, 100, 200, 500, 1000, 2000, 5000, and 10000.

Example Commands:

```
set interface lag-1
set interface lag-1 holddown-down-delay 1000
set interface lag-1 holddown-up-delay 5000
```

Example:

```
supervisor@rtbrick.net: cfg> show config  interface lag-1
{
  "rtbrick-config:interface": [
    {
      "name": "lag-1",
      "holddown-down-delay": "1000",
      "holddown-up-delay": "5000"
    }
  ]
}
```

Configuring LAG for Redundancy

While configuring LAG for redundancy, you must specify the session ID to associate the LAG with the Redundancy Session. LAG can identify its Redundancy session with this mapping.

Syntax:

set link-aggregation interface <interface-name> **description** <description>
set link-aggregation interface <interface-name> **member-interface** <member-interface-name> **lacp-mode** <active | passive>
set link-aggregation interface <interface-name> **member-interface** <member-interface-name> **lacp-timeout** <long | short>
set link-aggregation interface <interface-name> **member-interface** <member-interface-name> **port-priority**
set link-aggregation interface <interface-name> **minimum-link-count** <minimum-link-count>

set link-aggregation interface <interface-name> **mode** <static | lacp>
set link-aggregation interface <interface-name> **redundancy-session-id** <1-65535>
set link-aggregation interface <interface-name> **system-id** <system-id>

Attribute	Description
description	Link aggregation interface description.
member-interface-name	Name of the link member.
minimum-link-count	Minimum number of active member links required for the link aggregation interface. Default 1.
lacp-mode <active | passive>	Mode of the link aggregation interface, static or lacp. Default mode: lacp.
redundancy-session-id	The value for the redundancy group session ID range from 1 to 65535.
system-id	Redundancy System ID of link-aggregation interface.

Example for LAG configuration for redundancy.

The following configuration defines a LAG named 'lag-1' with LACP as the protocol. The minimum link count specifies that at least one physical link must be active for the LAG interface to be considered operational. The redundancy session ID (100) associates this LAG with the configured redundancy session. The system identifier identifies the LACP system and the member interface adds a physical port that participates in the aggregated link.

```
set link-aggregation interface lag-1
set link-aggregation interface lag-1 mode lacp
set link-aggregation interface lag-1 minimum-link-count 1
set link-aggregation interface lag-1 redundancy-session-id 100
set link-aggregation interface lag-1 system-id a8:b5:7e:8f:66:43
set link-aggregation interface lag-1 member-interface ifp-0/1/260
```

Example Configuration:

```
supervisor@rtbrick>cbng2.rtbrick.net:: cfg> show config link-aggregation interface
lag-1
{
    "rtbrick-config:interface": [
      {
        "interface-name": "lag-1",
        "mode": "lacp",
```

```
        "minimum-link-count": 1,
        "redundancy-session-id": 100,
        "system-id": "11:22:33:44:55:66",
        "member-interface": [
          {
            "member-interface-name": "ifp-0/0/4"
          }
        ]
      }
    ]
  }
```

To access the RESTCONF API that corresponds to this CLI, click here.

6.5.3. LAG Operational Commands

Show Commands

Viewing LAG Running Configuration

The following command displays the LAG running configuration on the system.

Syntax:

```
show config link-aggregation
```

Example: LAG Running Configuration

```
supervisor@dev1: cfg> show config link-aggregation
{
  "rtbrick-config:link-aggregation": {
    "interface": [
      {
        "interface-name": "lag-4",
        "mode": "lacp",
        "minimum-link-count": 4,
        "member-interface": [
          {
            "member-interface-name": "ifp-0/0/1",
            "lacp-mode": "active",
            "lacp-timeout": "long"
          },
          {
            "member-interface-name": "ifp-0/0/4",
            "lacp-mode": "active",
            "lacp-timeout": "long"
          }
        ]
      }
    ]
```

```
  }
}
```

Viewing LAG Information

The following command displays the LAG information.

Syntax:

show lag <options>

Option	Description
<interface-name>	Displays information for a specific LAG interface
detail	Displays detailed LAG information
mode <mode>	Displays information for a LAG mode: static or LACP

Example: Viewing LAG Information

```
supervisor@rtbrick: cfg> show lag detail

  Lag interface name: lag-3
  Status:             Up
  Minimum link count: 2
  Mode:               lacp
    Member interface name: ifp-0/0/1
      Actor system id: 04:f8:f8:e9:bc:83
      Actor key: 107
      Partner system id: 04:f8:f8:e9:bf:83
      Partner key: 43
    Member interface name: ifp-0/0/5
      Actor system id: 04:f8:f8:e9:bc:83
      Actor key: 107
      Partner system id: 04:f8:f8:e9:bf:83
      Partner key: 43
```

Viewing LAG QoS Policer Counters

The following command displays the QoS Policer Counters.

Syntax:

show qos policer counter

Example 1: QoS policer counter

```
supervisor@rtbrick: cfg> show qos policer counter
Interface                       Level  Units      Total            Received
Dropped
lag-27                          1      Packets    0                0
0
                                       Bytes      0                0
0
lag-27                          2      Packets    0                0
0
                                       Bytes      0                0
0
lag-27                          3      Packets    0                0
0
                                       Bytes      0                0
0
lag-27                          4      Packets    0                0
0
                                       Bytes      0                0
0
lag-28                          1      Packets    0                0
0
                                       Bytes      0                0
0
lag-28                          2      Packets    0                0
0
                                       Bytes      0                0
0
lag-28                          3      Packets    0                0
0
                                       Bytes      0                0
0
lag-28                          4      Packets    203              0
203
                                       Bytes      18270            0
18270
lag-29                          1      Packets    0                0
0
                                       Bytes      0                0
0
lag-29                          2      Packets    0                0
0
                                       Bytes      0                0
0
lag-29                          3      Packets    20591812         18850600
1741212
                                       Bytes      21291933608      19491520400
1800413208
lag-29                          4      Packets    0                0
0
                                       Bytes      0                0
0
lag-27-egress                   1      Packets    0                0
0
                                       Bytes      0                0
0
lag-27-egress                   2      Packets    0                0
0
                                       Bytes      0                0
```

```
0
lag-27-egress                       3       Packets    2011928          2011928
0
                                            Bytes      2116548256       2116548256
0
lag-27-egress                       4       Packets    180377           180377
0
                                            Bytes      15574914         15574914
0
lag-28-egress                       1       Packets    0                0
0
                                            Bytes      0                0
0
lag-28-egress                       2       Packets    0                0
0
                                            Bytes      0                0
0
lag-28-egress                       3       Packets    2019661          2019661
0
                                            Bytes      2124683372       2124683372
0
lag-28-egress                       4       Packets    178226           178226
0
                                            Bytes      15398532         15398532
0
lag-29-egress                       1       Packets    0                0
0
                                            Bytes      0                0
0
lag-29-egress                       2       Packets    0                0
0
                                            Bytes      0                0
0
lag-29-egress                       3       Packets    1999328          1999328
0
                                            Bytes      2103293056       2103293056
0
lag-29-egress                       4       Packets    183300           183300
0
                                            Bytes      15893128         15893128
0
```

Syntax:

show qos policer counter <lag interface>

Example 2: QoS policer counter for a specified LAG

```
supervisor@rtbrick: cfg> show qos policer counter lag-29
Interface                           Level  Units      Total            Received
Dropped
lag-29                              1       Packets    0                0
0
                                            Bytes      0                0
0
```

```
lag-29                          2       Packets    0               0
0
                                        Bytes      0               0
0
lag-29                          3       Packets    21241103        19499891
1741212
                                        Bytes      21963300502     20162887294
1800413208
lag-29                          4       Packets    0               0
0
                                        Bytes      0               0
0
```

Example 3

```
supervisor@rtbrick: cfg> show qos policer counter lag-29-egress
Interface                       Level   Units      Total           Received
Dropped
lag-29-egress                   1       Packets    0               0
0
                                        Bytes      0               0
0
lag-29-egress                   2       Packets    0               0
0
                                        Bytes      0               0
0
lag-29-egress                   3       Packets    2071701         2071701
0
                                        Bytes      2179429452      2179429452
0
lag-29-egress                   4       Packets    187300          187300
0
                                        Bytes      16221128        16221128
0
```

6.6. HQoS

6.6.1. Hierarchical Quality of Service (HQoS) Overview

Hierarchical Quality of Service (HQoS) is a traffic classification and prioritization framework that allows you to provide different Service Level Agreements(SLAs) on bandwidth usage. It allocates network resources to services on a prioritized basis. This is achieved by classifying, policing, shaping, scheduling and remarking the traffic based on service types. The HQoS service can be applied to Ethernet, IPv4, IPv6 or MPLS packets. The framework supports QoS at multiple levels. At only one level it allows you to allocate resources between services, but when configured at multiple levels through HQoS, it allows complex prioritization schemes.

The RtBrick Full Stack (RBFS) uses the following HQoS mechanisms:

- **Classifier:** Classifies each incoming packet as belonging to a specific class, based on packet contents. Supported classifiers are Behavior Aggregate (BA) and Multifield (MF). In the BA classifier, packets are classified according to the CoS field: IEEE 802.1p, IPv4/v6 ToS/TC, or MPLS EXP. In the MF classifier, packets are classified using additional fields in the IP header: source IPv4/IPv6 prefix, destination IPv4/IPv6 prefix, L4 source port, L4 destination port, and/or IP protocol.
- **Policer:** Policer is implemented in the ingress to drop the unwanted traffic. Policer supports the Committed Information Rate (CIR), the Committed Burst Size (CBS), the Peak Information Rate (PIR), and the Peak Burst Size (PBS). Drop behavior is to either mark traffic as green, yellow, or drop.
- **Queuing:** Drop unqualified packets in advance using the Weighted Random Early Detection (WRED) technology in the case of congestion to ensure bandwidth for qualified services. This is performed at the egress.
- **Scheduler:** Manage traffic on a device using different algorithms for queue scheduling. Such algorithms include Fair Queuing (FQ), Weighted Round Robin (WRR), and Strict Priority (SP). Queues can be connected to schedulers and schedulers can also be connected to other schedulers.
- **Shaper:** Shaper is implemented in the egress, traffic shaping involves buffering and delaying traffic to shape the flows. Shapers are implemented either on queues or schedulers.
- **Remarking:** Remarking allows you to rewrite the outgoing packet's codepoint. Remarking can be performed in the ingress or the egress side of the hardware pipeline.

The figure below shows how QoS does ingress and egress traffic management

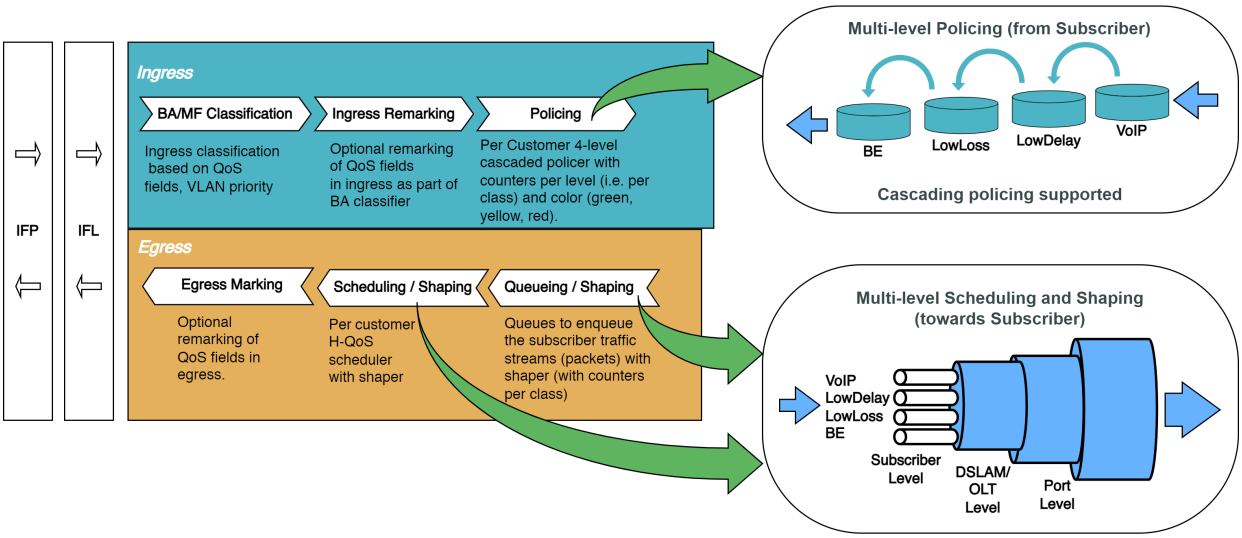


Figure 117. Ingress and Egress Traffic Management in QoS

The sections below provide a description of various HQoS components that are configured for both ingress and egress traffic.

- QoS Profiles
- Behavior Aggregate (BA) Classifier
- Multifield (MF) Classifier
- Remarking
- Policer
- Class-Policer-Map
- Queueing
- Traffic Class to Queue Mapping
- Queue-Group
- Scheduler
- Priority Propagation
- Shaper
- Scheduler Mapping
- L2TP QoS
- Multi-level H-QoS : Level-1 to Level-5

QoS Profiles

A profile configuration defines the QoS profile that is attached to either a Subscriber interface or an L3 interface.

Profile maps the following QoS constructs to a Subscriber or an L3 interface:

- Behavioral Aggregate (BA) Classifier
- Multifield (MF) Classifier
- Class Policer Map
- Policer
- Class Queue Map
- Scheduler Map
- Remark Map

Behavior Aggregate (BA) Classifier

Classifiers assign the class to which a packet belongs. BA classification is performed on the ingress and maps incoming packet codepoint to a predefined class. BA Classification relies upon markings (that is, codepoint) placed in the headers of incoming packets:

- IEEE 802.1p: Priority - 3 bits
- IPv4: Type of Service byte (ToS) - 8 bits.
- IPv6: Traffic Class (TC) - 8 bits.
- MPLS: Experimental bits (EXP) - 3 bits.

Classifier configuration has the following guidelines and limitations:

- IEEE 802.1p and IPv4/IPv6 classifiers are applied on either Subscriber IFL or L3 IFL by attaching the BA classifier to a profile.
- MPLS Exp classifiers are applied either globally or per instance (to support multiple VPN marking schemes) by attaching the classifier globally or to an instance.
- For IPv4, classification can only be performed based on Type of Service (ToS). Currently, DSCP-based classification is not supported.

- For IPv6, it is possible to classify traffic based on Traffic Classes (TC).
- For EXP classification, RBFS uses the uniform mode to copy MSB 3-bits from 8-bits IPv4-ToS or IPv6-TC to the EXP field at the time of MPLS encapsulation at the remote box. IPv4/IPv6 Classifiers do not classify labeled traffic, hence MPLS Classifier is required for the same.
- Default class for Queue or Policer is *class-0*. If for an incoming packet's *codepoint* there is no class mapping configured under a classifier, the packet will be classified as *class-0*.
- RBFS supports 8 **classes**: *class-0* to *class-7*.

Ingress Remarking

Ingress remarking is achieved by configuring the "remark-codepoint" field in the Classifier. Ingress remarking rewrites the IPv4-ToS or IPv6-TC field of the incoming packet at the ingress side with configured remark-codepoint. Note that the ingress remarking is not supported for the BA Classifier with match-type MPLS-EXP.

Multifield (MF) Classifier

Multifield (MF) classifiers assign the class to which a packet belongs based on multiple fields. Unlike the BA classifier, where only CoS fields are used for classification, the MF classifier additionally uses the following fields:

- **class**: traffic class of the packet (class-0 to class-7) set by prior BA classifier
- **source prefix**: source IPv4 or IPv6 prefix
- **destination prefix**: destination IPv4 or IPv6 prefix
- **protocol**: UDP or TCP
- **source port**: UDP or TCP source port
- **destination port**: UDP or TCP destination port
- **qos markings**: IPv4 TOS or IPv6 TC header value

The actions supported by a Multifield Classifier are:

- **class**: traffic class to be set (class-0 to class-7)
- **Remark codepoint**: remark codepoint for ingress remarking



RBFS treats all the incoming IPv4-TOS or IPv6-TC QoS field values

in the incoming packet as untrusted. So a user is required to set action-remark-codepoint in the MF Classifier configuration to mark the QoS bits in the IP header of the outgoing packet. If action-remark-codepoint is not configured in the MF Classifier, the default value 0 shall be marked in the packet.

The Multifield Classifiers can be bound globally (global.qos.global.config) or via QoS profile (global.qos.profile.config). The global Multifield Classifier applies to all traffic from any instance or interface. The Multifield Classifier assigned via the QoS profile applies only to ingress traffic received on the interface where the profile is bound to it.

The Multifield Classifier is processed after BA classification which allows it to match on selected class from BA classification or to change the assigned class by more granular match conditions. Both classification stages (BA and MF) are optional, they can be combined or used alone, controlled by configuration.

Multifield Classifiers cannot be bound to MPLS core interfaces. Therefore, the downstream traffic (from core to subscriber) should be classified via global Multifield Classifier, while upstream traffic (from subscriber to core) can be classified via Multifield Classifier from the QoS profile, which is instantiated per subscriber with an implicit match on ingress logical interface (InLIF).



- RBFS supports 8 **classes**: *class-0* to *class-7*.
- Per instance MF classifier for MPLS traffic is not supported in RBFS because of hardware limitations.
- The default class for Queue is **class-0**. If an incoming packet has no MF classification configured, it will be classified as *class-0*.
- The default Policer class is determined by VLAN priority. If an incoming packet lacks an MF classification mapping, it will be classified according to the packet's VLAN priority bit.
- Priority 1 is reserved for BA Classifier ACL entries, therefore the recommendation is to use Priority starting from 2 for MF Classifier
- If multiple ACL entries are hit in MF having the same priority, the result is unpredictable. So recommendation is to use different priorities for different ACL entries.

Traffic Class Remapping Based on Subscriber Queue Profile

RBFS supports the remapping of downstream traffic classes based on the subscriber QoS profile. This feature helps prevent packet drops when traffic is classified into higher classes (such as class-4 and above) for subscribers with a 4-queue profile. Although, traffic is still counted per class, with 8 class counters available, all traffic from class-4 to 7 is redirected to the queue assigned to class-0. The remapping is automatically enabled for all 4-queue subscribers but is limited to Q2c access-leaf devices.

This feature helps to reduce queue usage and enables more flexible queue profiles, allowing the use of 4-queue subscribers instead of always requiring 8 queues. This feature is enabled, by default.

Match MPLS traffic

If MF Classifier is to be applied for MPLS traffic (that is, DOWNSTREAM traffic), match MPLS traffic has to be configured in the MF ACL. If not configured, traffic may or may not match the MF ACL entry in the h/w.

Ingress Remarking

Ingress remarking is achieved by configuring the “action remark-codepoint” in the MF Classifier. Ingress remarking rewrites the IPv4-ToS or IPv6-TC field of the incoming packet at the ingress side with configured remark-codepoint.

RADIUS Controlled Dynamic MF Classifier

As described in *RBFS RADIUS Services* document dynamic MF Classifier mapping is supported. The dynamic MF Classifier when configured overrides the MF Classifier mapped via QoS profile for the corresponding subscriber but not other subscribers.

For information about configuring the MF Classifier, see Multifield Classifier (MFC) Configuration.

Layer 2 Access Control Lists (ACL) Priority Bit Egress Classifier

L2 ACL p-bit egress classifier assigns the class to which a packet belongs based on traffic direction (ingress) and outer VLAN priority fields.

- **direction**: Direction of the packet, that is, ingress
- **service-outer-vlan-priority**: Qualifies the packet based on priority bit in the the outer VLAN (IEEE-802.1p)
- **interface-meta-data**: To qualify the packet based on L2 ACL, interface metadata is mandatory (type-1)

The actions supported by a L2 ACL priority bit Egress Classifier are:

- **forward-class**: traffic class to be set on the qualified packets (class-0 to class-7)



- When EVPN-VPWS L2 interfaces are required to create L2 business services, the shared code points have to be corrected at egress to ensure the correct classification towards the subscriber. The egress classification of packets based on L2 ACL is supported.

Policer

Policer defines the rate at which certain applications can access the hardware resource. So as to rate-limit the traffic from an application, the policer hard-drops the unwanted packets on the ingress side.

In RBFS, policers support the "**two-rate, three-color**" type in a 4-level cascaded mode. This means that each policer level has two rates (CIR and PIR) and three colors (green, yellow and red) with two token buckets as shown below.

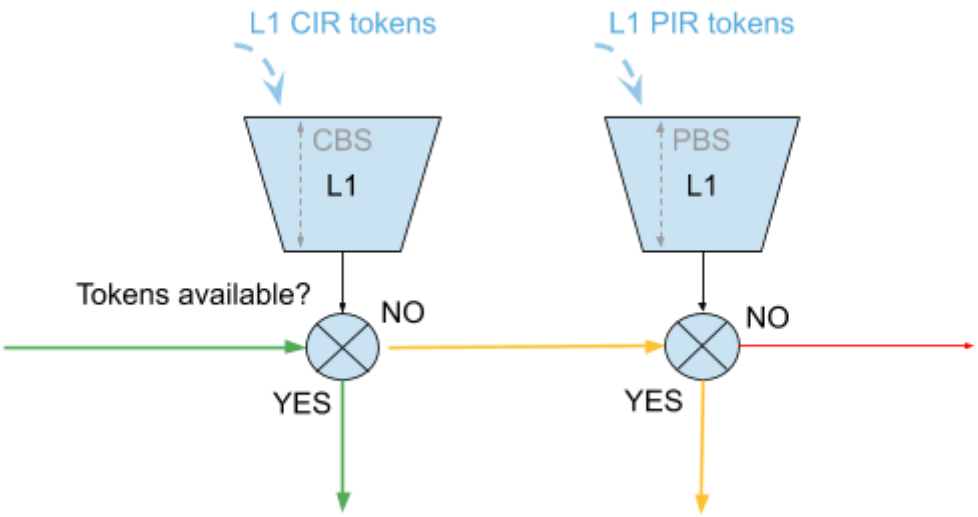


Figure 118. HQoS Policer Configuration

This means that traffic below CIR is marked green. Traffic above CIR but below PIR is yellow and above PIR is red. Traffic marked red will be dropped. Traffic marked yellow can be demoted by changing ToS, TC, or EXP using remark map.

In 4-level cascade mode, unused tokens can be passed from higher priority levels to lower priorities where level 1 has the highest and level 4 has the lowest priority as shown in the figure below.

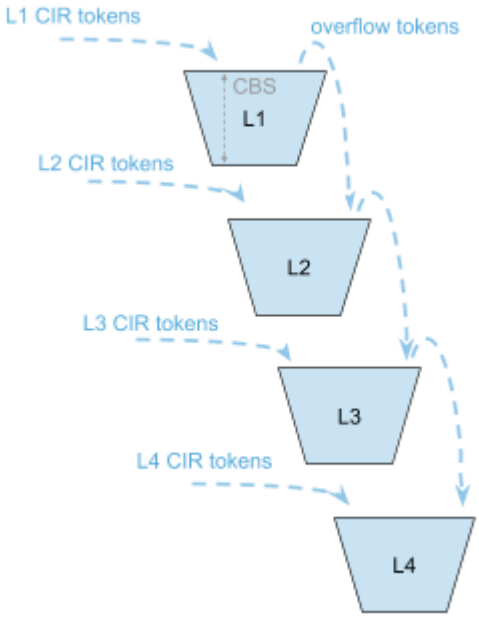


Figure 119. HQoS Policer Configuration in 4-level Cascade Mode

Therefore a lower level configured with CIR 0 can still serve traffic if higher priority levels are not consuming all available tokens.

The available tokens per level are calculated by remaining CIR credits from upper levels and additional credits based on configured CIR per level. Per default, the resulting tokens are not limited. The optional max CIR rate attribute limits tokens from CIR and upper levels. Let us assume levels 1 and 2 are both configured with a CIR of 2Mbps. Without max CIR or max PIR (default behaviour) level 2 can reach up to 4Mbps (level 1 CIR/PIR plus level 2 CIR/PIR). This can be limited by max CIR (for example, 3Mbps). If both level 1 and level 2 have a committed information rate (CIR) of 2Mbps, then level 2 can reach a maximum of 4Mbps (which is the sum of level 1 CIR and level 2 CIR) without any consideration for the maximum CIR. However, the maximum CIR is not relevant for level 1.



In a single-level (levels=1) mode, only level 1 CIR & PIR rates should be configured.

Example

	CIR	RX	TX	PIR	RX	TX
L1	2M	1M	1M	2.5M	1M	1M
L2	3M	20M	9M	3.5M / max CIR 8	20M	8M
L3	4M	20M	0M	4.5M	20M	1M
L4	1M	20M	0M	1.5M	20M	0M
SUM	10M	61M	10M	12M	61M	10M

- Here, M indicates Mbps (Megabits per second)

In columns 2 through 4 of the preceding example table, L1 consumes only 1Mbps of the available 4Mbps and passes the remaining 3Mbps to L2 which adds 6m based on their own configured CIR resulting in 9m.

In columns 5 through 7 of the preceding example table, L1 consumes only 1Mbps of the available 4Mbps and passes the remaining 3m to L2 which adds 6Mbps based on their own configured CIR resulting in 9Mbps. But because of the CIR limit set to 8Mbps, only 8Mbps of 9Mbps can be used at this level. The remaining 1Mbps is now passed to L3 which does not add additional CIR-based credits. In both examples, L4 would be able to reach up to 10Mbps if upper levels are not consuming credits.

RADIUS Controlled Dynamic Policer

The RBFS RADIUS services support dynamic policer rate updates. The dynamic policer rate when configured affects only the QoS instance of the corresponding subscriber but not other subscribers.

Class-Policer-Map

Since RBFS supports up to 8 classes but only four policer levels, there is a need to map multiple classes to the same policer level. A *class-policer-map* defines such mappings. Using class-policer-map configuration, one can map any class to any supported policer level (that includes mapping multiple or all classes to the same level). Similar to a policer, a class-policer-map is attached to a profile.



If class-to-level mapping is not configured, no policing will be

applied to the traffic for that class.

Queueing

Queuing helps to drop unwanted traffic in advance at the ingress side in case of congestion. This is to ensure bandwidth for qualified services.

RBFS supports the following queueing techniques:

- Tail Drop (TD): This is a conventional congestion avoidance technique. When the network is congested, drop subsequent packets from the queue.
- Weighted Random Early Detection (WRED): This technique requires configuring “Minimum Threshold”, “Maximum Threshold” and “Drop Probability”, which define the start and end range where packets may get discarded. When the average queue size is below the minimum threshold, no packets will be discarded. The drop_probability parameter can be used to specify the drop probability at the max threshold. When the average queue size is between the min and max threshold, the drop probability increases linearly from zero percent (at the min threshold) to drop_probability percent (at the max threshold). When the average queue size is greater than the maximum threshold, all packets are discarded.

  When the average queue size is less than the “Minimum Threshold”, no packets will be discarded.

  When the average queue size is greater than the “Maximum Threshold”, all packets are discarded.

  When the average queue size is between “Minimum Threshold” and “Maximum Threshold”, the drop probability increases linearly from zero percent (at the minimum threshold) to drop probability (at the max threshold).



- Default queue within a queue group is the one mapped to *class-0*. If the classification is not configured for an incoming packet’s codepoint, the packet will be classified as *class-0*. This will be mapped to queue mapped to *class-0* in *Class-Queue-Map*. For more information, see Traffic Class to Queue Mapping.
- Maximum supported Queue size depends upon DRAM/OCB memory. Since OCB is external memory, hardware does not

limit the size that can be configured per Queues.

RADIUS Controlled Dynamic Queue

As described for *RBFS RADIUS Services* document dynamic Queue buffer size updates are supported. The dynamic Queue buffer values when configured affect only the QoS instance of the corresponding subscriber but not other subscribers.

Traffic Class to Queue Mapping

The traffic class to queue mapping defines the mapping of classes and queues. The Traffic Class to Queue Mapping is attached to a profile.



- You cannot map two classes to the same queue. The class to queue mapping is 1:1.
- If a queue group is created with four queues, only class-0 to class-3 can be mapped to the queues in class-queue-map; that is, class-4 to class-7 cannot be used.
- In a single-queue/1 queue scenario:

  All traffic/streams classification [MFC/BA Classifier] will be categorized as class-0 only.

  Class-0 will be assigned to a single queue.

Queue-Group

A Queue Group defines the Queue bundle. A Queue Group contains bundle of either 1 or 4 or 8 queues.

Scheduler

A scheduler configuration defines scheduler parameters such as type and shaping rate. The shaping rate defined for a scheduler applies to queue(s) associated with it. NOTE: For 1 Queue in Queue-Group, scheduler is not applicable.

The following scheduler types are supported:

- **Fair Queueing (FQ)**: Uses a round-robin approach to select the next packet to service. This method ensures that all the flows are serviced equally. Configure scheduler type as *fair_queueing* to create FQ scheduler.

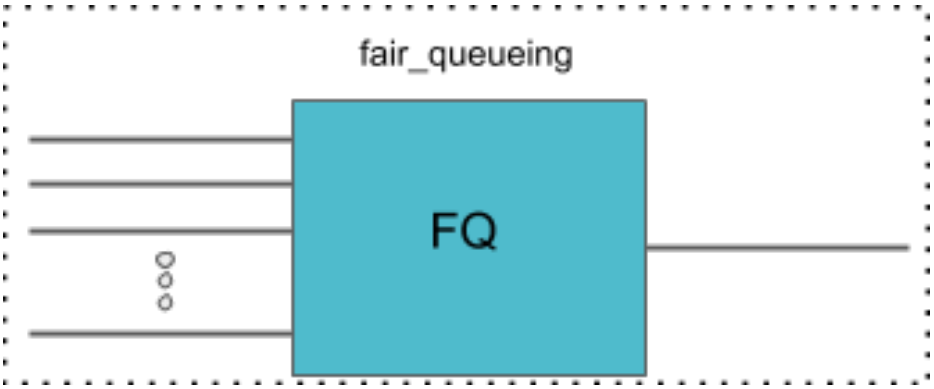


Figure 120. Fair Queueing (FQ)

- **Weighted Fair Queueing (WFQ)**: Uses a round-robin approach but with no guarantee of flow being serviced equally (like in FQ). The rotation of the next packet to service is based on the weight that is assigned to each flow. Configure scheduler type as *weighted_fair_queueing* to create WFQ scheduler.

  Supported weight: 1 to 253

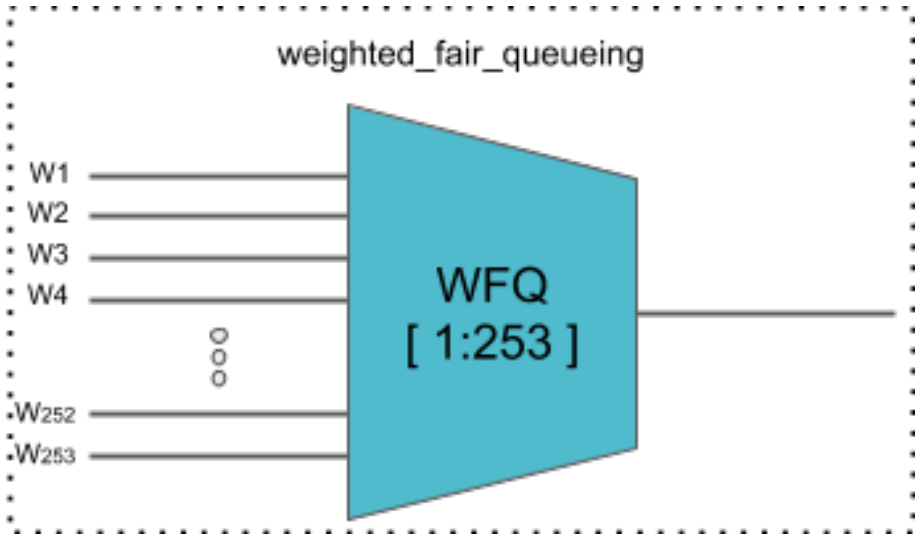


Figure 121. Weighted Fair Queueing (WFQ)



In any WFQ scheduler, the lower the weight, the higher the bandwidth portion is awarded.

- **Strict Priority (SP)**: Uses priority-based approach to service the flow. SP schedulers are supported in “hybrid” mode only. Hybrid mode combines FQ-WFQ schedulers using strict priority.



The priority order for SP is: **strict_priority_0 > strict_priority_1 > strict_priority_2 > strict_priority_3** (where **strict_priority_0** being highest priority and **strict_priority_3** being lowest)

The following SP scheduler types are supported:

- **2 Strict Priority (2SP)**: Uses SP between 1-FQ and 1-WFQ. There are the following types of 2SP hybrid schedulers:

  type **“2sp_wfq_independent”**

  Supported weight: 1 to 63

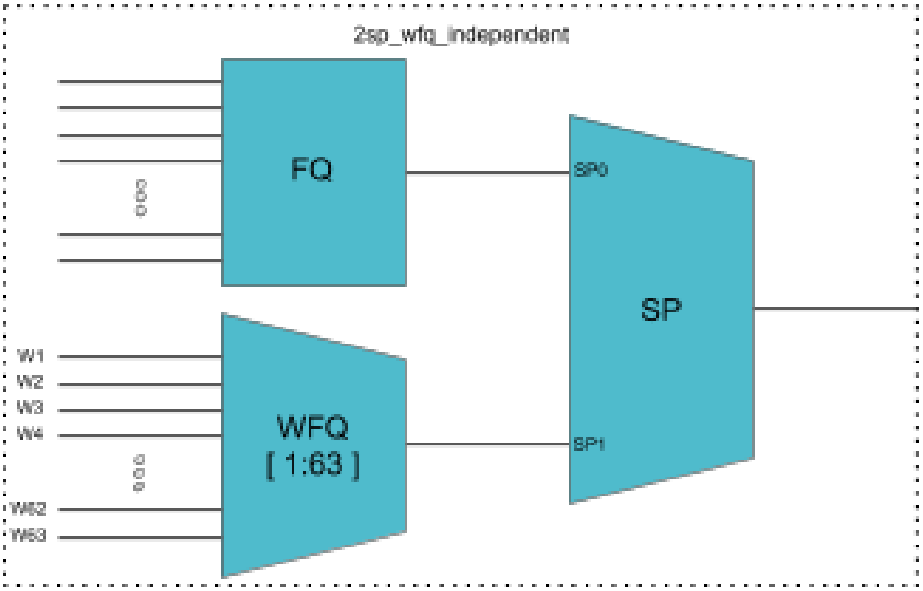


Figure 122. 2sp_wfq_independent

- type **“2sp_wfq_discrete”**

  Supported weight: { 1, 2, 3 }

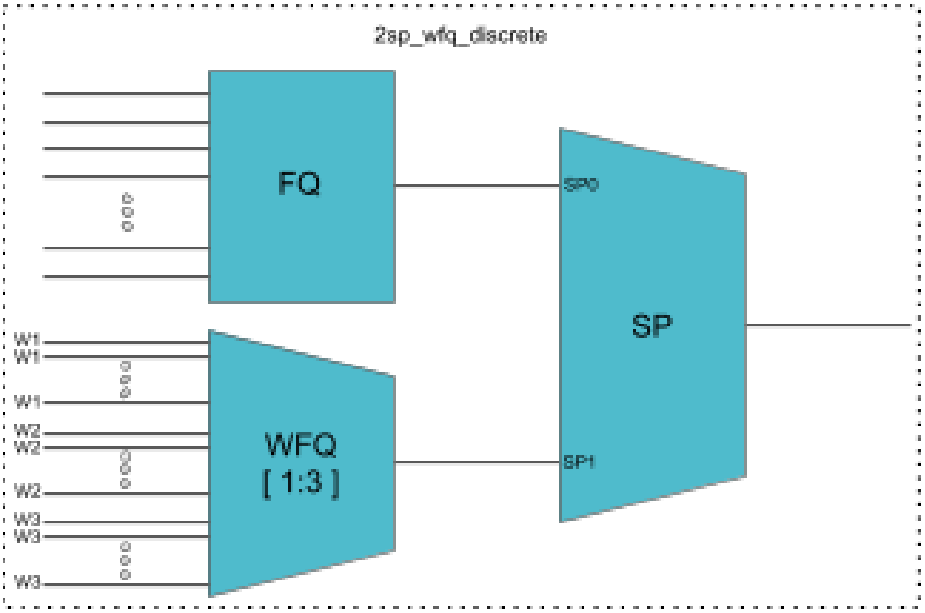


Figure 123. 2sp_wfq_discrete

- type **“wfq_independent_2sp”**

Supported weight: 1 to 63

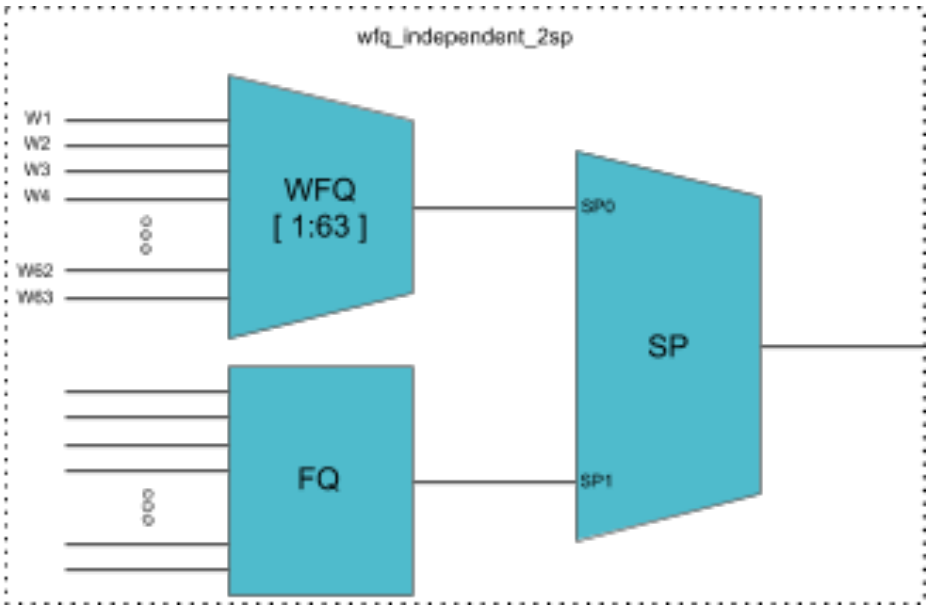


Figure 124. wfq_independent_2sp

- type **“wfq_discrete_2sp”**

  Supported weight: { 1, 2, 3 }

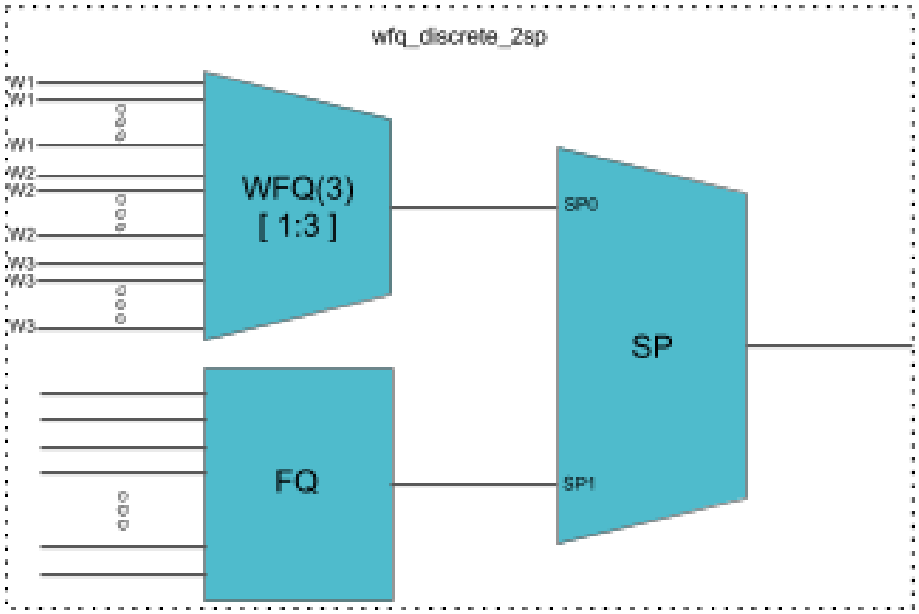


Figure 125. wfq_discrete_2sp

- **3 Strict Priority (3SP)**: maps 2-FQs and 1-WFQ

  type: **“3sp_wfq_discrete“**

  Supported weight: { 1, 2 }

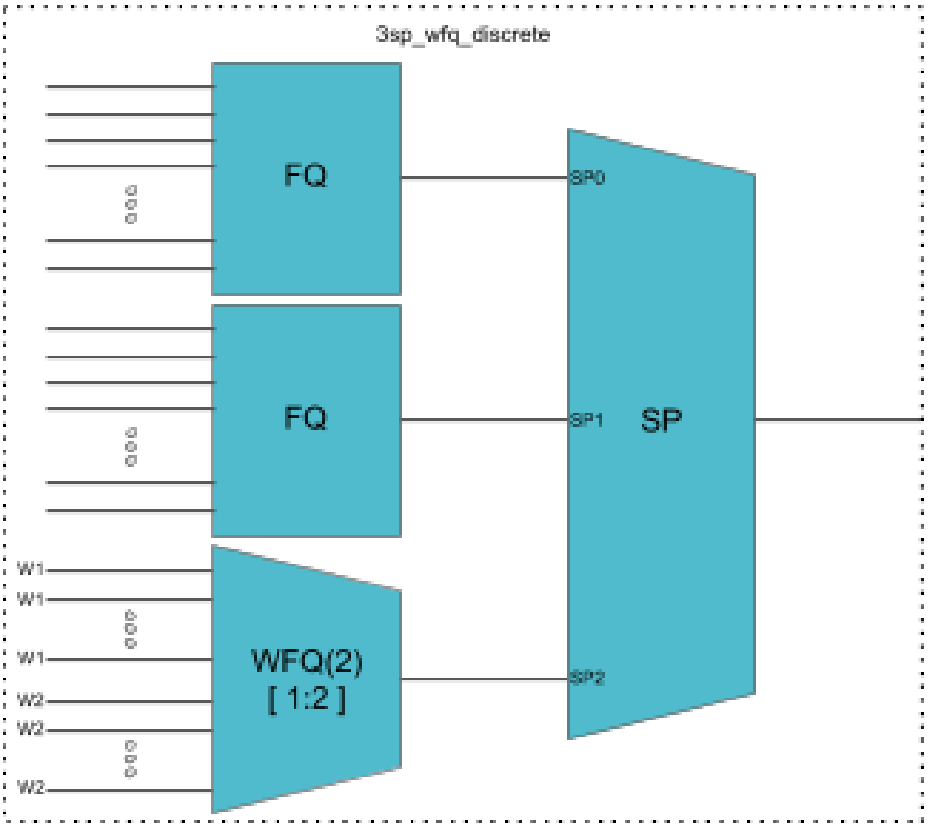


Figure 126. 3sp_wfq_discrete

- **4 Strict Priority (4SP)**: maps 4-FQs using SP

  type **“strict_priority"**

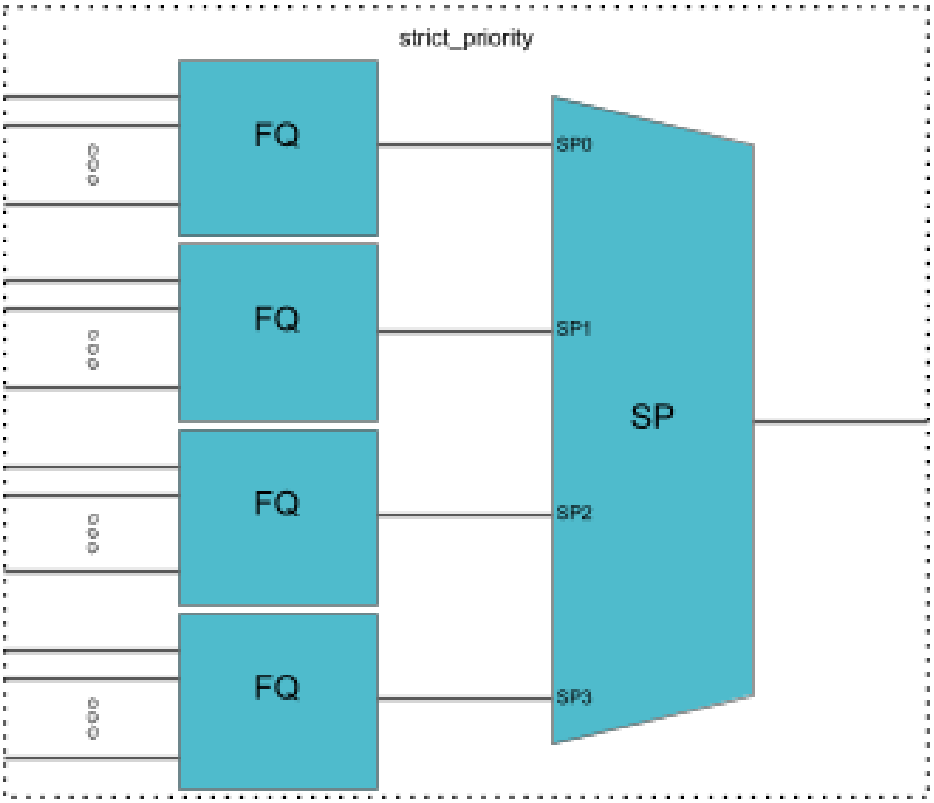


Figure 127. strict_priority

Priority Propagation

Hierarchical QOS (HQoS) on RBFS is implemented by connecting or chaining queues to scheduler elements (Q —> SE), scheduler elements to each other (SE —> SE), and scheduler elements to ports (SE —> PORT). Each scheduler element can have different child connection points based on types described in the section Scheduler.

This means that sched_0 in the example below is not scheduling between the attached queues, but between the different child connection points SP0 to SP3. The scheduler element sched_0 cannot differentiate between Q1 and Q2 in this example because both are connected to SP2.

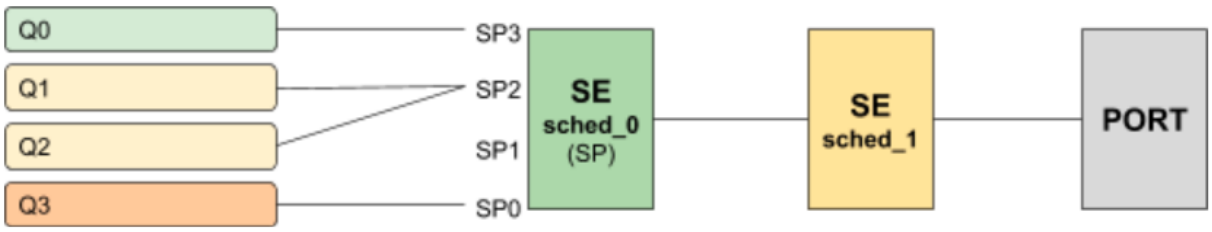


Figure 128. Priority Propagation

Without priority propagation, each scheduler element can have multiple child connection points but just one parent connection point. Therefore traffic leaving a scheduler element cannot be differentiated by the parent scheduling element. The parent scheduler element sched_1 receives the traffic from sched_0 on the selected child connection point. As already mentioned scheduling within a scheduler element happens between child connection points. Second, a scheduler element has only one parent connection point which can be connected to a child connection point of another scheduler element (output of sched_0 input of sched_1). This results in the situation that all traffic from this SE is handled equally regardless of the queue. This may lead to dropped priority traffic like voice or control traffic in case of congestion in parent elements. For example, if sched_1 has a shaping rate lower than the one of sched_0, it will drop traffic unaware of its original priority.

This problem is addressed with priority propagation which is enabled by default.

With priority propagation, the scheduler elements operate in a dual-flow mode with high and low-priority flows. The credits generated from the physical interface will be consumed by all attached high-priority flows first and only the remaining credits will be available for low-priority flows. In this mode, an implicit FQ element

is created for each scheduler element. All queues assigned to low-priority flow will be attached to this element.

An additional composite option of the scheduler element allows also the differentiation between multiple low-priority queues if required. This composite type is created implicitly and does not need to be configured.

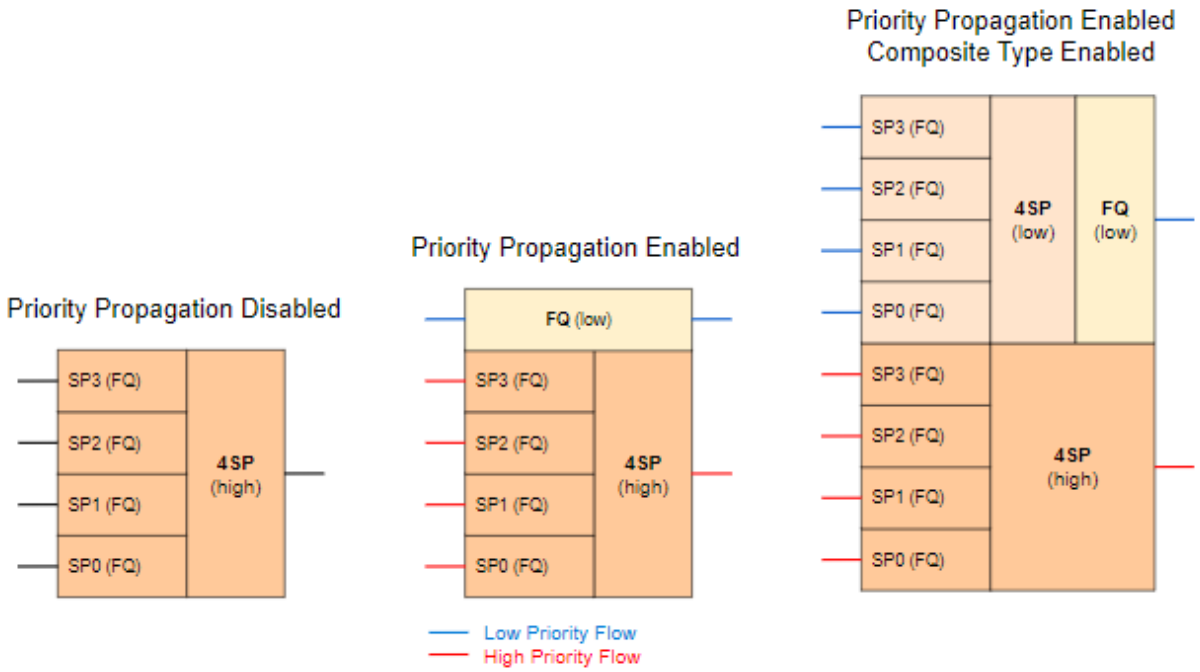


Figure 129. Priority Propagation - Composite Option

Without priority propagation enabled, each scheduler element consumes only one scheduler resource compared to two elements if enabled. The composite type consumes three scheduler elements.

With priority propagation disabled, all traffic is considered a high-priority flow.

Now for each queue, we can select if connected to high-priority or low-priority flow where high-priority flow is selected per default if not explicitly mentioned.

Assuming the example as before but with priority propagation and Q0 assigned to low-priority flow and Q1 - Q3 assigned to high-priority flow.

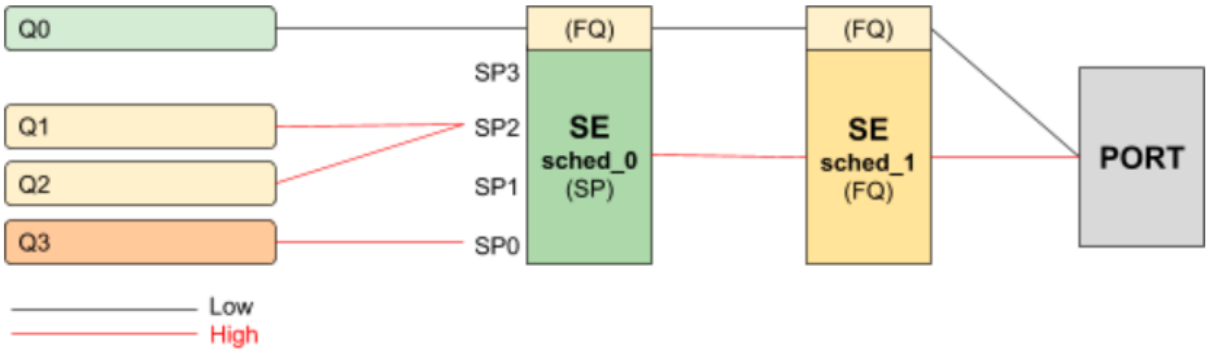


Figure 130. Priority Propagation - Low/High Priority Flows

The figure below shows a typical multi-level QoS configuration without priority propagation on the left and with priority propagation on the right side.

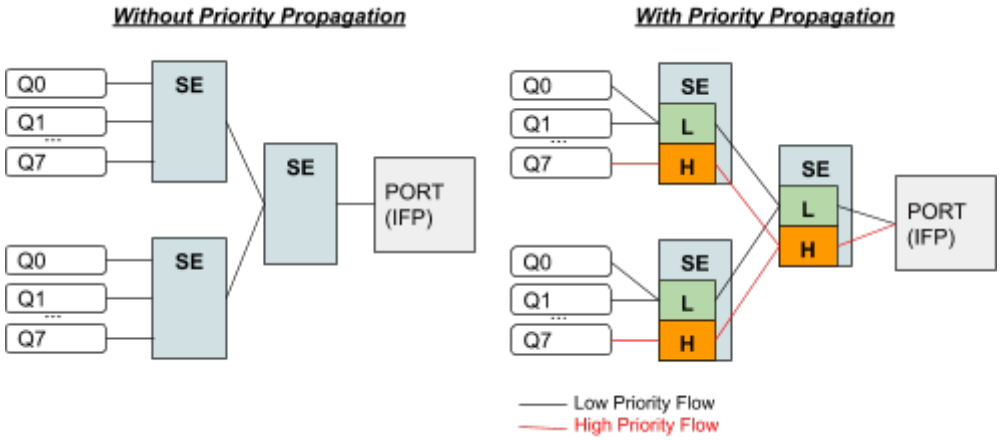


Figure 131. Multi-level QoS configuration with/without priority propagation

The credits generated from the physical interface will be consumed by high-priority flow first and the remaining credits will be available for low-priority flow. The high-flow traffic at any one element is scheduled based on the type and connection point. Between schedulers, it depends on how they are connected to the parent scheduling element. Per default all levels there is FQ for low and FQ for high-priority flows. The port scheduler is also FQ.

In this mode, each shaper supports two different rates for low and high-priority where the actual shaper rate is the sum of low and high-priority rates. If the low-priority rate is zero, this flow is only served if the high-priority flow is not consuming all credits. An example might be a high rate of 9Mbps and a low rate of 1Mbps which results in 10Mbps for low-priority flow if high-priority flow is not consuming any packets but at least 1Mbps is ensured.

The following example shows a typical access service provider configuration with priority propagation enabled with and without composite type.

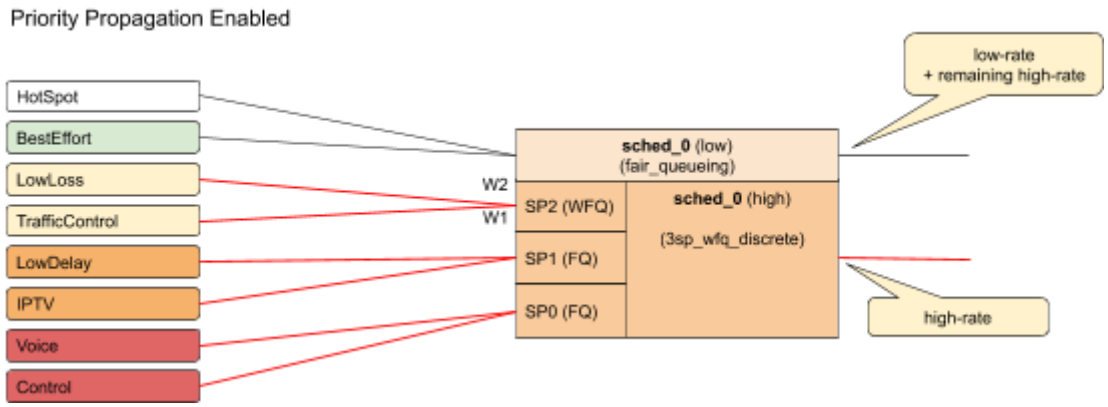


Figure 132. Priority Propagation Enabled

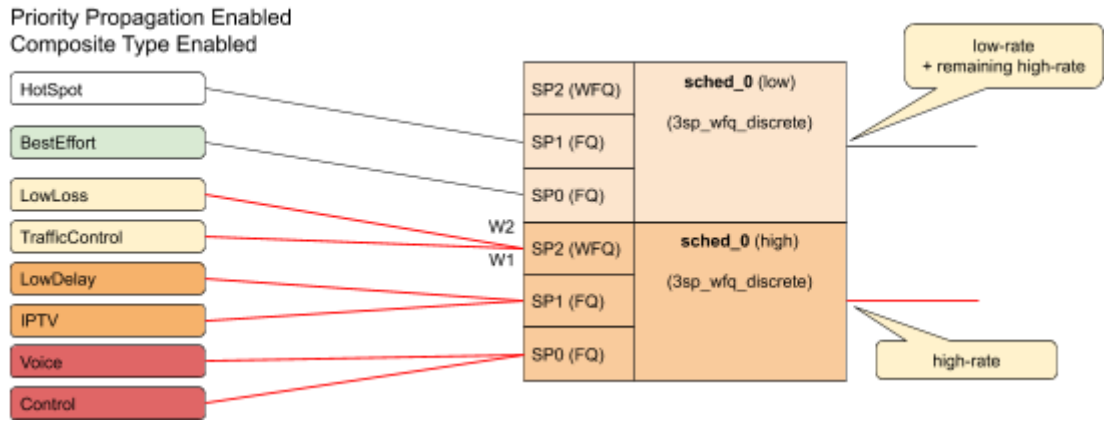


Figure 133. Priority Propagation and Composite Type Enabled

Simple Priority Propagation Scheduling Example

Without priority propagation, the parent scheduler drops traffic equally from all classes as it is unaware of priorities:

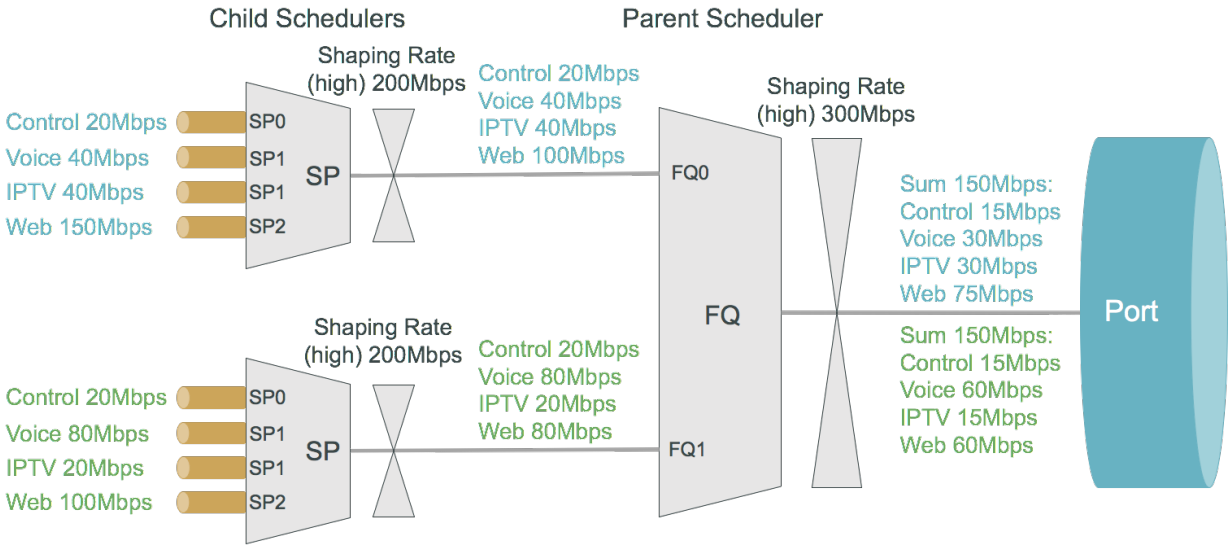


Figure 134. Priority Propagation Scheduling Example

With priority propagation, the parent scheduler serves high-priority flows first as

shown in the figure below:

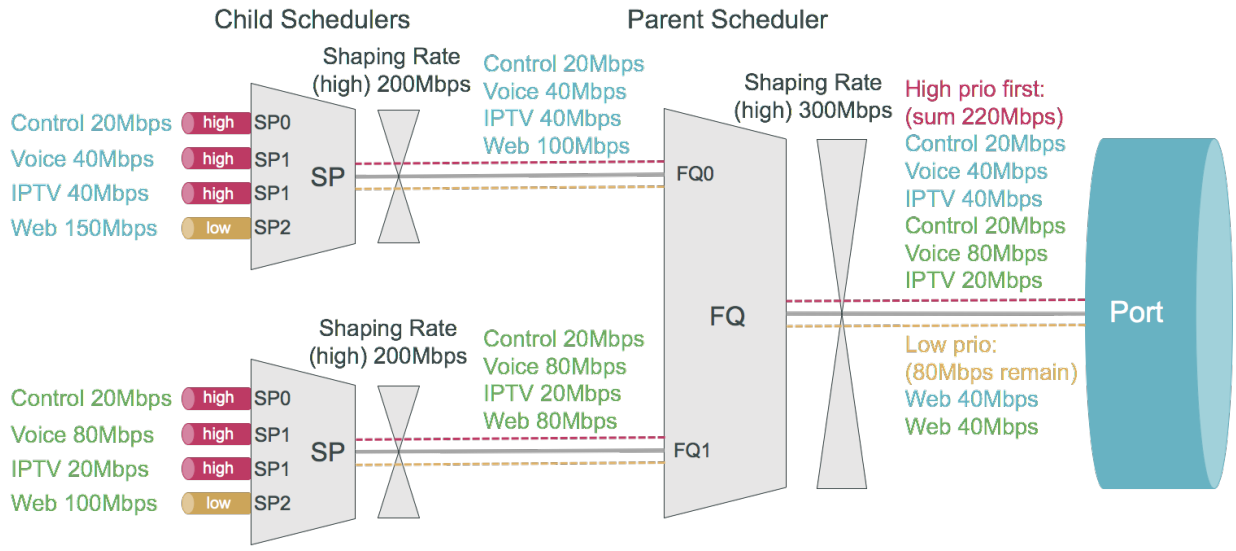


Figure 135. Priority Propagation Scheduling Example

With priority propagation and dual-flow shaping, the parent scheduler serves high-priority flows first up to the high-flow shaping rate:

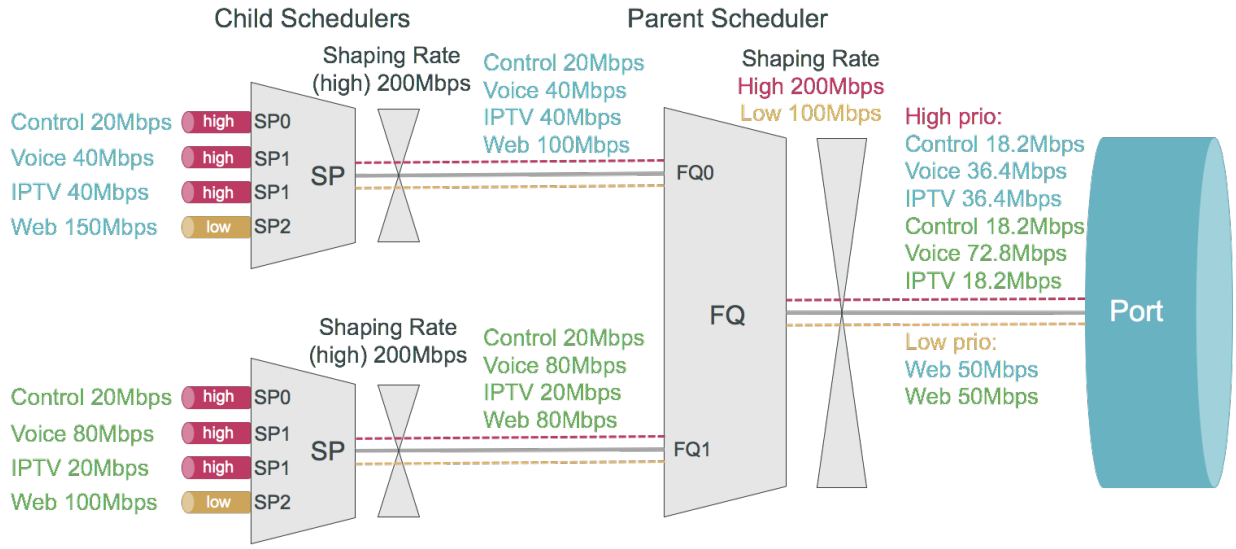


Figure 136. Priority Propagation Scheduling Example

Shaper

Shaper is used to rate-limit the traffic at the egress. In RBFS, shapers can be attached to both Queue and Scheduler.

A shaper configuration defines the shaping rate in Kilo-bits-per-seconds (Kbps).



- Setting the shaping rate to 0 (zero) sets the rate to unlimited. Hence it is recommended to configure at least 1 Kbps so that

shaping takes place.

- If shaping rates are to be unconfigured, it needs to be done at all scheduler levels.

Low-rate Shaping

The Low-rate Shaping feature performs queueing and scheduler-level traffic shaping to rates lesser than 1000 Kbps so that the higher-priority (voice) traffic to flow at optimal levels.



Low-rate Shaping is supported only on high-priority flows, that is high-flow configuration parameter.

RBFS Access-Leaf and Multiservice Edge platforms have been enabled with Low-rate Shaping by default. For information about the Low-rate Shaping feature enabled platforms, see section 'Feature/Resource Usage" in the *Platform Guide*.

RADIUS Controlled Dynamic Shapers

RBFS RADIUS services support dynamic shaper updates. The dynamic shaper when configured affects only the QoS instance of the corresponding subscriber but not other subscribers.

Scheduler Mapping

Scheduler Map defines the set of relationships between parents and children in egress scheduling hierarchy. A child in a Scheduler Map configuration can be either Queue or Scheduler. A parent in a Scheduler Map configuration can be either a Port or Scheduler.



For 1 Queue in Queue-Group, scheduler-map is not applicable.
Connection Point and Weight

Child-queue or child-scheduler in a scheduler map configuration is connected to the parent-scheduler at "**connection point (CP)**". Connection point configuration also has "**weight**" associated with it if the parent has a WFQ scheduler corresponding to that connection point. The valid connection point value for a child to connect to parent **WFQ/FQ** scheduler is **no_priority** and to connect to parent **SP/Hybrid** scheduler is between **strict_priority_0** to **strict_priority_3** (based on a number of Strict Priority points in parent scheduler).

Connection Types

There are five connection types in a scheduler map entry:

- queue_to_port
- queue_to_scheduler
- scheduler_to_scheduler
- scheduler_map_to_scheduler_map
- scheduler_to_port



- For the **queue_to_port** connection type, the scheduler has no role.

Remarking

The packet markers set the codepoint in a packet to a particular value, adding the marked packet to a particular behavior aggregate. When the marker changes the codepoint in a packet, it "remarks" the packet. The codepoint in a packet can be IPv4-ToS, IPv6-TC, MPLS-EXP, or IEEE 802.1p field.

The following remarking options are supported in RBFS:

- IEEE 802.1p : Priority - 3 bits.
- IPv4: Type of Service byte (ToS) - 8 bits.
- IPv6: Traffic Class (TC) - 8 bits.
- MPLS-IPv4: MPLS Experimental bits (EXP) - 3 bits.
- MPLS-IPv6: MPLS Experimental bits (EXP) - 3 bits.

IPv4/v6 and IEEE 802.1p remark-map are applied on an interface - subscriber-ifl or l3ifl using Profile Name.

MPLS-IPv4/v6 remark-map is applied either globally or per instance (to support multiple VPN marking schemes) using Remark-Map Name.

In RBFS, remarking can be performed at the ingress or egress:

- **Ingress remarking** is achieved by configuring the **remark-codepoint** field in the Classifier. Ingress remarking rewrites the IPv4-ToS or IPv6-TC at the ingress

side with configured remark-codepoint. The configured remark-codepoint can be modified again at the egress side using remark-map. The ingress remarking is supported for IPv4, IPv6, and IEEE 802.1p BA classifiers. Ingress remarking is supported in MF Classifier as well.

- **Egress remarking** is achieved by configuring the **remark-map**. Remark Map is the mapping of **match-codepoint** and **color** to **remark-codepoint**. Egress remarking helps to remark the IPv4-ToS / IPv6-TC field in the IP header, or to write the EXP field in the MPLS label(s), or to write the IEEE 802.1p field in the VLAN header.

Here *Color* is used to set different *remark-codepoint* for same *match-codepoint* based on color marked by the Policer (i.e. *green* or *yellow*). Color is a mandatory field in remark-map. To set the same *remark-codepoint* for a *match-codepoint* irrespective of color, we have to set color as "*all*".

IPv4-ToS, IPv6-TC, or MPLS-EXP remarking:

- If the *remark-codepoint* is not configured in the BA Classifier or there is no hit in MF Classifier, match-codepoint in the remark-map is the ToS/TC value of the incoming IP packet.
- If the *remark-codepoint* is configured in the BA Classifier and there is no hit in the MF Classifier, match-codepoint is the same value as the remark-codepoint in the BA Classifier
- Irrespective of the *remark-codepoint* configured in the BA Classifier, if there is a hit in the MF Classifier the *match-codepoint* is the same value as the action remark-codepoint (0 if no action *remark-codepoint* configured) in the MF Classifier.

IEEE 802.1p VLAN remarking:



- Class-to-IP based Remark Map for L2TP UPSTREAM traffic is mapped globally. For more information, see the L2TP QoS section.
- In tunnel termination cases (i.e. Downstream traffic from core to Subscriber) the *remark-codepoint* in the MPLS BA Classifier is of no use. Therefore the *match_codepoint* in remark-map at the egress shall be the ToS/TC value of the incoming IP packet.
- In IP tunnel encapsulation cases (i.e. L2TP Upstream traffic

from Subscriber to core) the remark-codepoint in the IPv4-TOS BA Classifier is of no use. Therefore the match_codepoint in class-to-ip remark-map at the egress shall be the Class derived from ingress BA Classifier.

- If no MPLS remarking is configured for the Upstream traffic, EXP bits in the MPLS header are derived from IP header TOS/TC bits using the Uniform MPLS mode.
- For VLAN: Only class to IEEE 802.1p remarking is supported.
- For IPv4: Only ToS based remarking is possible. DSCP-based remarking is not possible.
- For IPv6: Only TC based remarking is possible.
- The VLAN priority remarking support for the platforms is as follows:

  UfiSpace S9600-72XC:

  match-codepoint: Value of the IPv4-ToS/IPv6-TC in the incoming IP packet or the remark-codepoint configured in the BA/MF Classifier

  remark-codepoint: Based on the VLAN priority

  Edgecore AS5916-54XKS:

  match-codepoint: MF or BA classifiers are used to determine class at the ingress

  remark-codepoint: Based on the VLAN priority

  QAX Platform: UfiSpace S9500-22XST

  In QAX platform, IP TOS to VLAN bits do not get directly mapped. The IP ToS is mapped to internal priority in classification, and then from internal priority VLAN priority bit remarking is performed.

- **IPv4/v6 and IEEE 802.1p** remark-map is applied on an interface - subscriber-ifl or l3ifl using Profile Name.
- **MPLS-IPv4/v6** remark-map is applied either globally or per-instance (to support multiple VPN marking schemes) using Remark-Map Name.

L2BSA L2X VLAN Priority Remarking:

The L2BSA L2X VLAN priority remarking support for the platforms is as follows: Only A10NSP switches support VLAN operations, access-leaf is transparent.

- Downstream Traffic (Remote ISP to Subscriber):

  On A10NSP Switch:

  The class derived from the VLAN Pbit Classifier is used to remark MPLS Exp and Outer VLAN IEEE-802.1 Pbit Value, inner VLAN Pbit is transparent.

  On Q2C Access Leaf:

  The received Outer VLAN IEEE-802.1 Pbit value is retained, explicit remarking at access-leaf is not supported.

- Upstream Traffic (Subscriber to Remote ISP):

  On Q2C Access Leaf:

  To remark the outgoing packet, global MPLS Exp remark map can be used.

  On A10NSP Switch:

  To remark the outgoing packet, VLAN IEEE-802.1 Pbit remark map can be used.

For more information about L2BSA configurations, see the L2BSA User Guide.

L2VPN VLAN Manipulation QoS Remarking:

- VLAN remarking allows for various VLAN manipulations (push, swap, push-push, swap-swap, swap-push) on the outer VLAN in double-tag or single-tag scenarios.
- VLAN remarking for VLAN manipulation involving POP operations (pop, pop-pop, pop-swap) is not supported.

Header Compensation

Queue Compensation

The rate at which the packets are dequeued from a queue depends on the credit received by that queue. The source of the credit received by a queue is the egress

port to which the queue is mapped. When a packet is dequeued, the credit balance is decreased by the packet size. But, the packet size that is used must be adjusted to model the packet size at the egress, rather than its actual size at the ingress queue. Thus the header compensation is used to adjust for the differences in header size between ingress queue and egress port. RBFS supports static header compensation configuration per queue (in bytes).

Port Compensation

Similar to queue header compensation where header compensation is performed at the per-queue level, RBFS supports the following header compensation at the per-port level:

- **Ingress Header Compensation**: In line with the header compensation option that we have per-queue, RBFS supports static header compensation configuration at the ingress to be used by the policing. Header compensation changes the effective size of the packet to compensate for changes in header size (such as the CRC removal) when considering the packet for policing. Unlike queue, RBFS ingress header compensation configuration is per ingress port (in bytes).
- **Egress Header Compensation**: In line with the header compensation option that we have per-queue or per-port at the ingress, RBFS supports static header compensation configuration at the egress. The egress header compensation configuration is per egress port (in bytes).



The supported range for header compensation is -64 to +64 bytes.

L2TP QoS

The Layer 2 Tunneling Protocol (L2TP) QoS for upstream is similar to any other locally terminated subscriber. The QoS Profile is mapped dynamically via RADIUS for the L2TP subscribers.

The L2TP QoS for Downstream requires IPv4-TOS based BA Classifier which is mapped to L2TP Tunnel. The same can be achieved by attaching *l2tp-classifier-name* in *global QoS* configuration.

```
forwarding-options {
    class-of-service {
        global {
            l2tp-classifier-name l2tp-ip;
```

```
        }
    }
}
```

For Downstream queueing, there is no change. Queueing is applied using QoS Profile similar to locally terminated Subscribers.

The following features are supported for L2TP QoS.

- Upstream

  BA Classifier: IEEE 802.1p

  Policing

    Policer statistics

  Remarking

  - L2TP upstream traffic can be remarked by configuring remark-code-point in the classifier configuration.
  - L2TP downstream traffic can be remarked by profile with the remark configuration. A match-codepoint value will be the class value derived from the l2tp-ip classifier.

- Downstream

  BA Classifier: IPv4-TOS

  Queueing/Scheduling/Shaping

    Queue statistics

  Remark-Map: IEEE 802.1p (Class to VLAN priority remarking)

Guidelines

- To avoid control traffic policing/shaping, the assumption is that the IEEE 802.1p bits in Upstream or IPv4-TOS bits in Downstream will be different for control and data traffic, control traffic is expected to have the highest precedence.

  Upstream classification is based on IEEE 802.1p bits.

  Downstream classification is based on IPv4-TOS bits of the outer IP header.

- PBIT (IEEE-802.1p) classification and policing for the upstream traffic from IPoE subscribers is not supported.

- Mark control plane traffic with codepoints based on protocols and layers (such as routing, signaling, and subscriber-management protocols, layer-2, layer-3) and ensure it is treated with higher priority.
- It is recommended to configure MFC (multi-field classifier) for the upstream classification for subscriber traffic.

Multi-level H-QoS : Level-1 to Level-5

A sample 5-level requirement looks like this.

Level-1 (IFP)

Physical Interface Shaper.

Level-2 (PON TREE)

Each PON tree is a TDM based shared medium with typically ~2.5 GBit/s (GPON) shared by up to 32 consumers (ONT or DPU).

Level-3 (DPU)

In case of FTTB there is a single DPU with multiple consumers via G.Fast DSL connected which requires an additional hierarchy. This level is not needed for FTTH or FTTC.

Level-4 (ANP or Session)

The Access Node Port (ANP) or outer VLAN level describes a single customer line. This might be an ONT in case of FTTH or DSL interface behind a DPU in case of FTTB. This level can be also represented on PPPoE sessions as long as just one session is permitted per VLAN.

Level-5 (QUEUE)

The Queue level shaper is required to limit the class-of-service bandwidth like Voice or IPTV traffic limit.

The figure below shows the diagram along with QoS representing Level-1 to Level-5 Hierarchical scheduling.

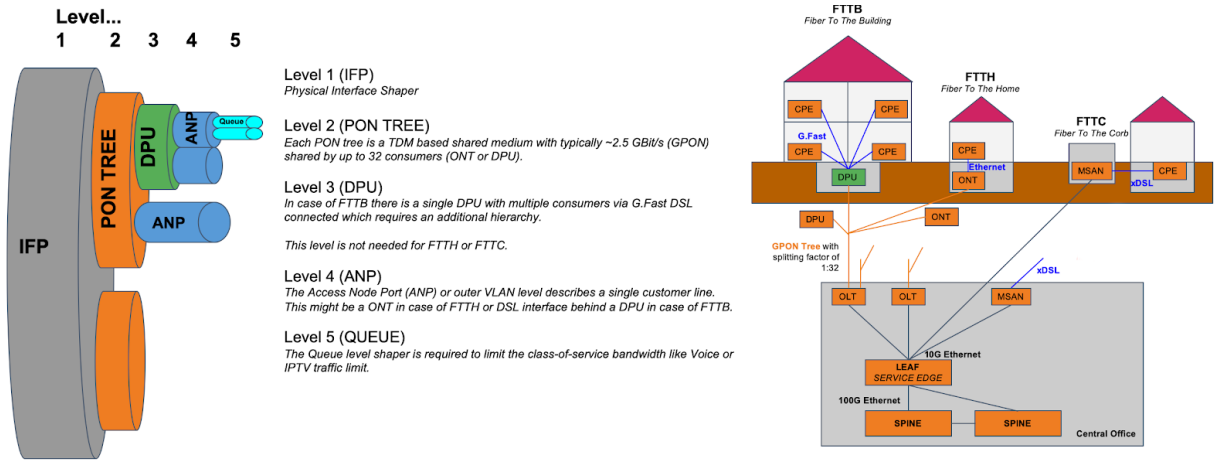


Figure 137. Level-1 to Level-5 Hierarchical Scheduling

Levels 4 and 5 are configured per logical interface (i.e. subscriber-ifl or l3-ifl). Separate scheduler-map representing levels 1 to 3 connectivity shall be statically configured and mapped to the corresponding physical interface (IFP).

The child scheduler in a subscriber scheduler map is connected to the parent scheduler in a physical interface scheduler map using the following way:

- Dynamically via RADIUS in case of dynamic subscribers like PPPoE sessions (Subscriber-IFL).

The figure below shows the same details as the preceding figure before with the different levels but from the DPU-PON-IFP scheduler-map point of view.

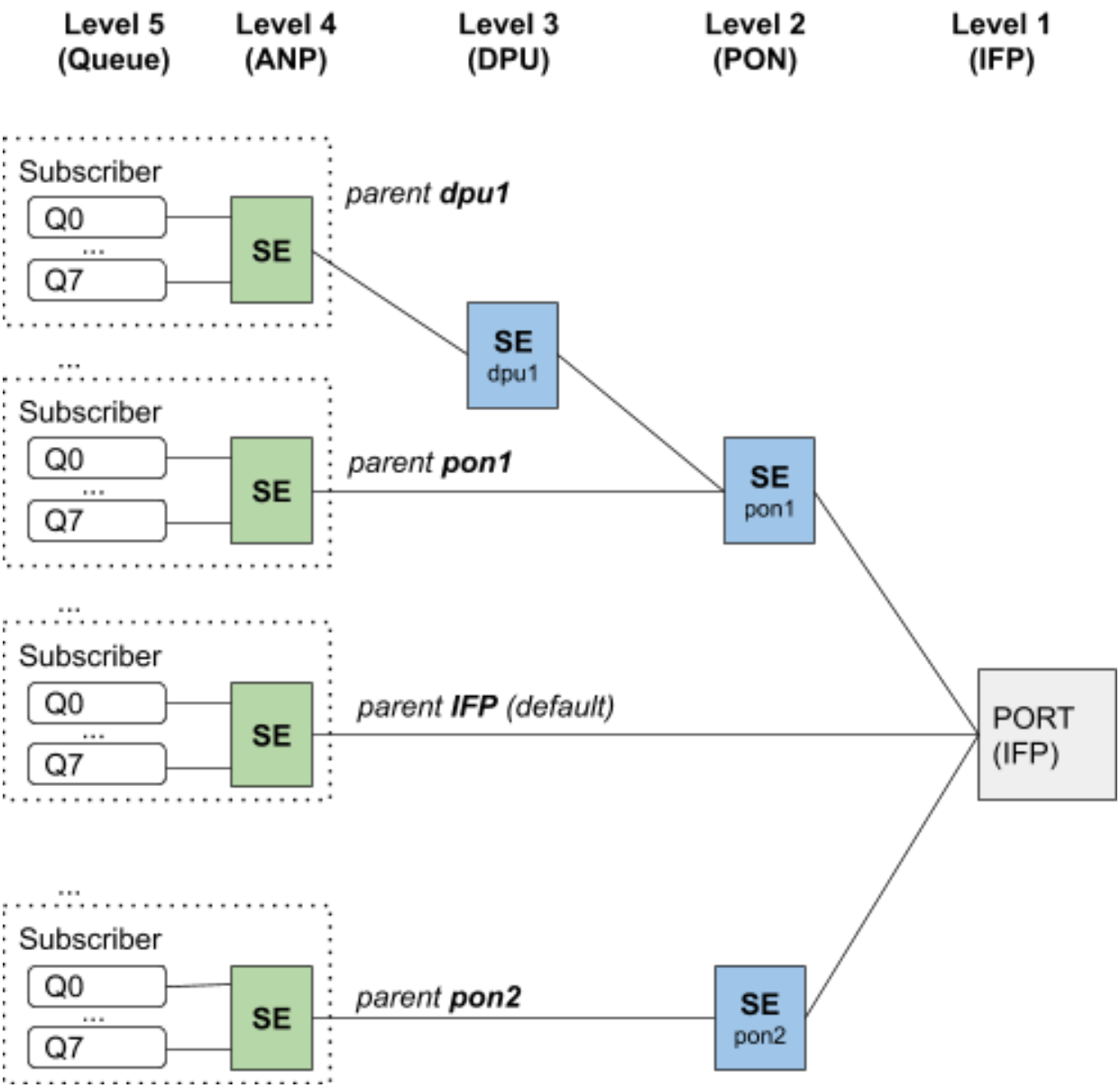


Figure 138. Level-1 to Level-5 Hierarchical scheduling (DPU-PON-IFP scheduler-map)

QoS Support for L2 and L3 Logical Interfaces

QoS is supported on Layer 2 and Layer 3 logical interfaces.

Support Interface-set for Grouping Logical Interfaces

An interface-set is a collection or group of logical interfaces (that is, L2 or L3) belonging to the same physical interface (IFP).

QoS Support for Interface-set Hierarchy

QoS can be configured at the interface-set hierarchy (service-group), and the IFLs belonging to this interface-set must configure the service-group scheduler to

connect to the PON scheduler or directly to the IFP.

Business Service QoS

A business service can be leveraged using an interface-set. A business service comprises of a number of logical interfaces. QoS can be configured at the interface-set hierarchy (service-group) and at the logical interface level as well.

The logical-interface-scheduler is connected to an interface-set (business service group) scheduler and the interface-set-scheduler can be connected to a PON-scheduler or directly to a port-scheduler.

MPLS HQoS

The MPLS HQoS has both UNIFORM and PIPE modes. These modes provide the following functionality:

- During MPLS Encapsulation, MPLS Mode is UNIFORM. MSB 3-bits from 8-bits IPv4-ToS or IPv6-TC are copied to the EXP bits of the newly added MPLS header(s).
- During MPLS Decapsulation, MPLS Mode is PIPE. 8-bit IPv4-ToS or IPv6-TC will be retained and hence it provides ToS/TC codepoint transparency.

For the Uniform MPLS mode mapping between IPv4-ToS or IPv6-TC to MPLS-EXP see the table below:

Mapping between IPv4-TOS/IPv6-TC to MPLS-EXP

IPv4-TOS / IPv6-TC	EXP	DSCP
0-31	0	0-7
32-63	1	8-15
64-95	2	16-23
96-127	3	24-31
128-159	4	32-39
160-191	5	40-47
192-223	6	48-55
224-255	7	56-63

Supported Platforms

Not all features are necessarily supported on each hardware platform. Refer to the *Platform Guide* for the features and the sub-features that are or are not supported by each platform.

6.6.2. HQoS Configuration

Basic QoS Configuration Elements

The figure below shows the dependencies between the various QoS configuration elements.

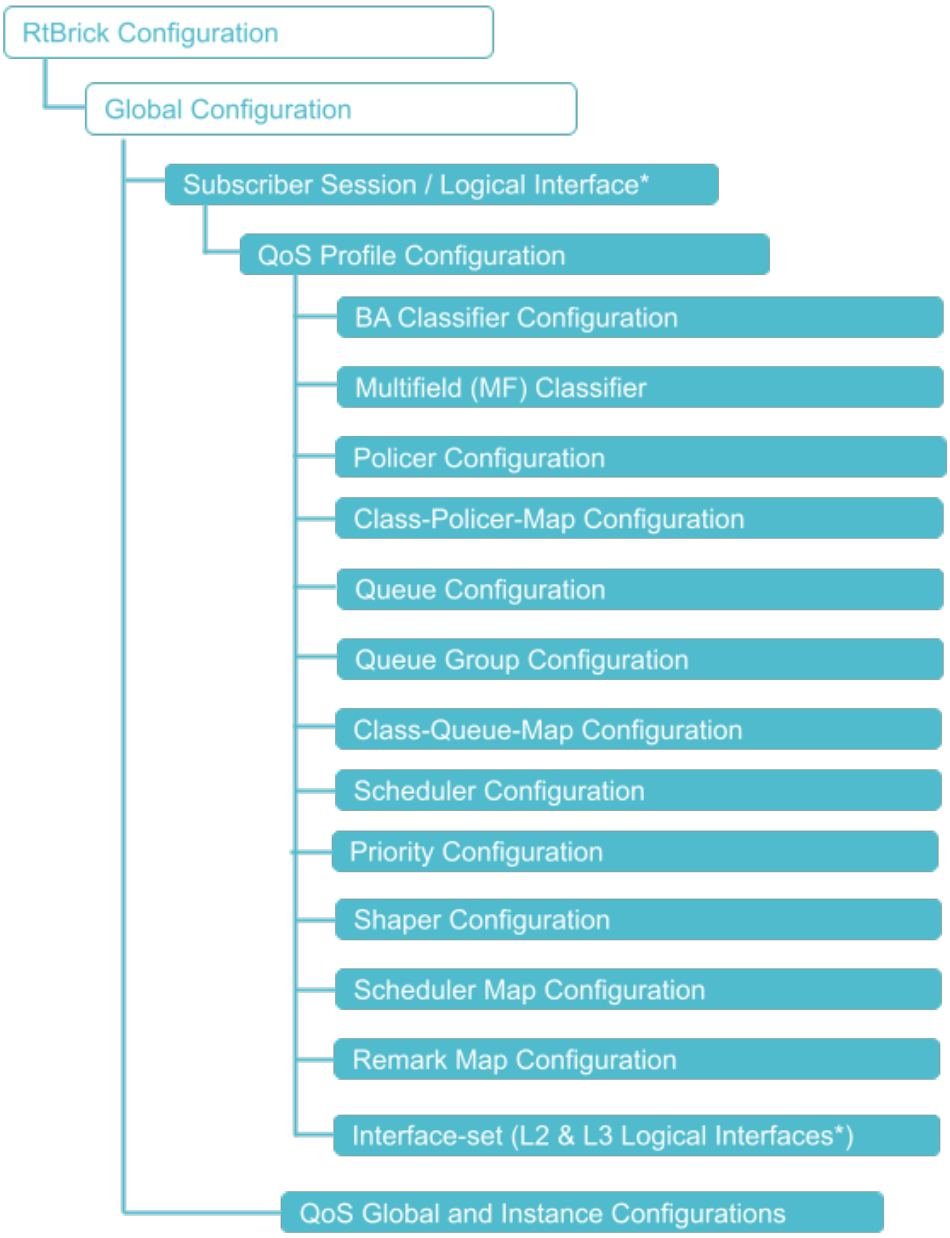


Figure 139. Dependencies between the various QoS configuration elements

To configure QoS, perform the following steps which include creating a QoS profile and enabling QoS on a Subscriber-Interface or L3-Interface.

1. Define a QoS profile with classifier, multifield-classifier, class-policer-map, policer, class-queue-map, scheduler-map, and remark-map based on SLAs.
2. Create a Behavioral Aggregate (BA) and/or Multifield (MF) classifier to classify the network traffic at the ingress.
3. Create a policer to police the classified traffic at the ingress with the CIR/PIR defined.
4. Create necessary class-to-policer-map to map the classes to policer levels

(mandatory for policing).

5. Create necessary queues with proper size to queue the classified traffic before egressing the traffic.
6. Create queue groups and define queue numbers (1/4/8).
   NOTE: For the system to initialize with a single queue in a Queue-Group, a system reboot is required.
7. Create the necessary class-to-queue map to map the classes to queues (mandatory for queuing).
8. Specify scheduler(s) with type as required.
9. (Optional) Create the shaper (low-flow / high-flow) and attach it to queue(s) and/or scheduler(s).
10. Specify a scheduler map to define a set of relationships between parent (scheduler or port) and child (queue/queue-group or scheduler) at the egress.
11. (optional) Create Remark-Map for QoS field remarking of the outgoing packet.
12. For the downstream traffic, map the MPLS EXP classifier either to an instance or global entity and/or the Multifield (MF) classifier as a global entity (refer to the figure above.)
13. (optional) Map the MPLS-IPv4/IPv6 remark-map either to an instance or configure it as a global entity.
14. For business services QoS, service-group scheduler is connected to PON scheduler or directly to an IFP.
    NOTE: The service group QoS profile is attached to an interface-set.



Priority propagation is enabled by default. To disable the Priority Propagation, we recommend doing this at the beginning and not during an active session.

Hierarchical QoS

Basic Quality of Service (QoS) is designed to provide a single level of traffic scheduling. In contrast, Hierarchical Quality of Service (HQoS) offers a more sophisticated approach to traffic treatment, utilizing multiple levels of scheduling in a hierarchical manner based on Service Level Agreements (SLAs).

The figure below shows the additional dependencies for Multi-level HQoS.

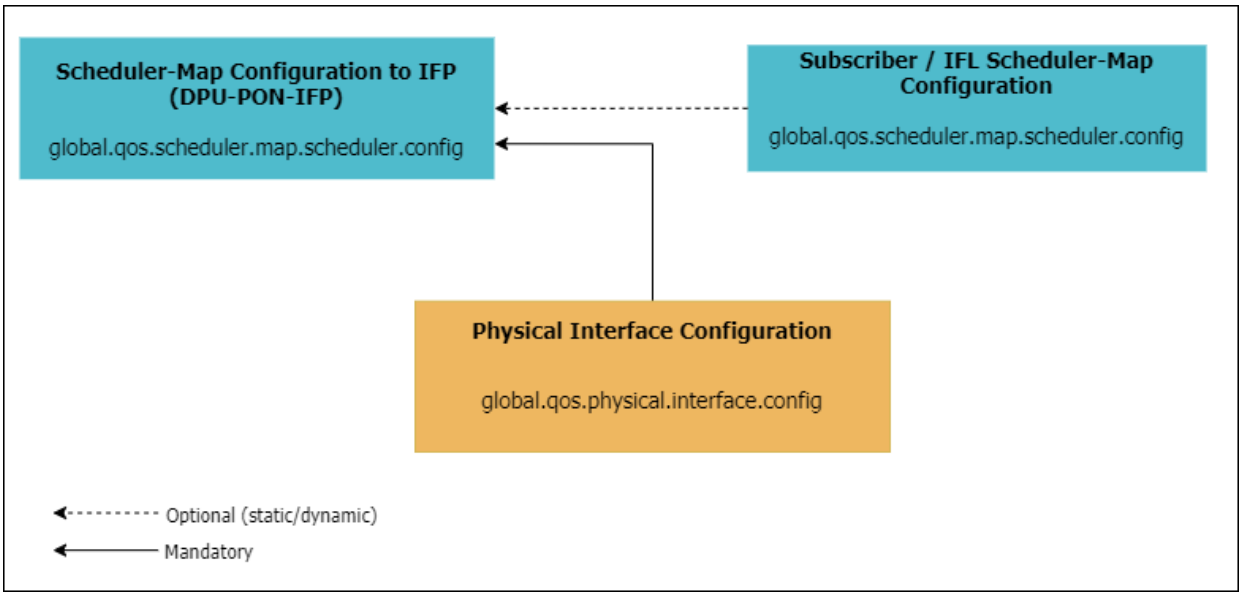


Figure 140. Dependencies for Multi-level HQoS

Below are the figures depicting an example of scheduling hierarchy.

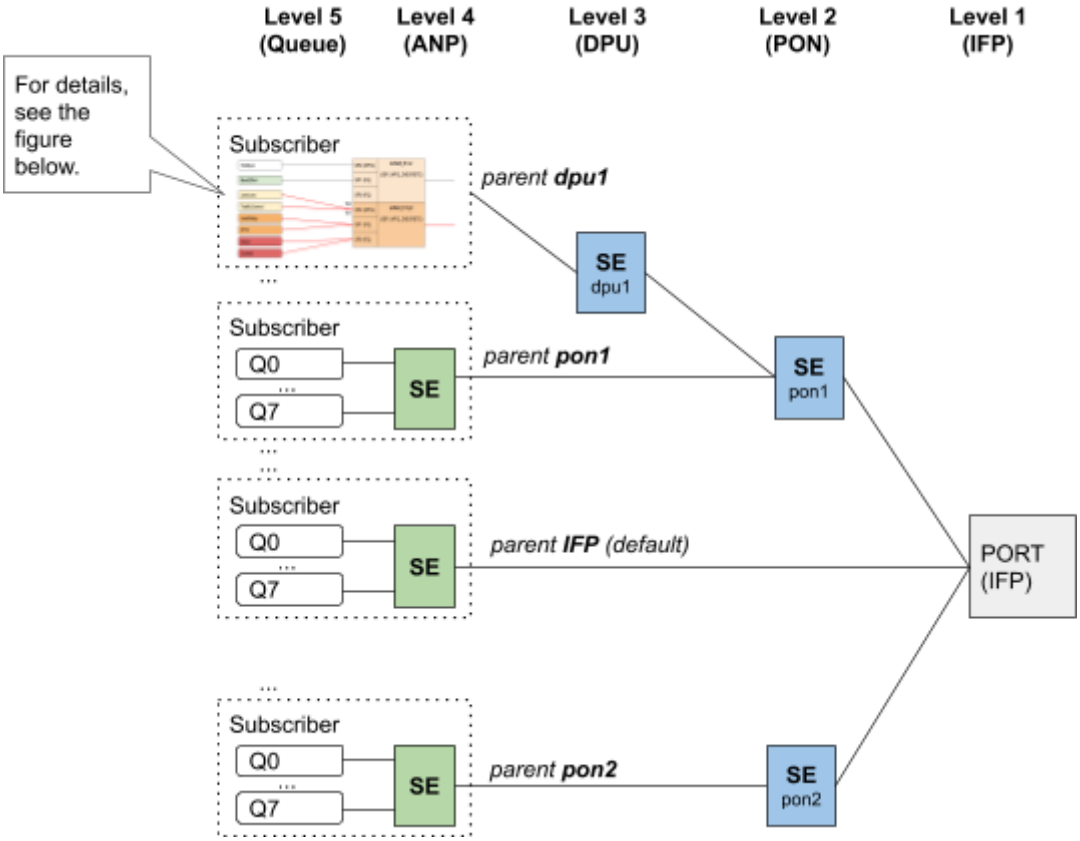


Figure 141. Example of scheduling hierarchy

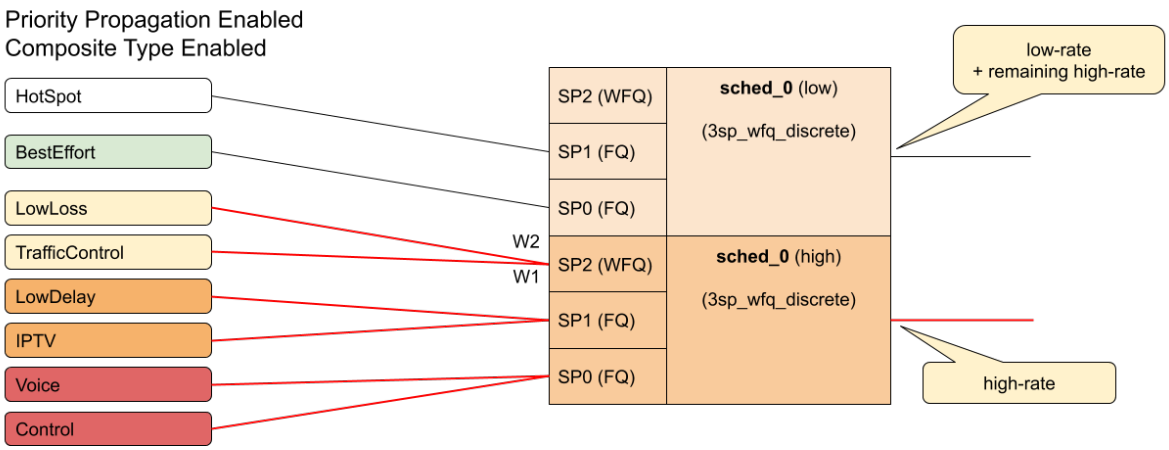


Figure 142. Example of scheduling hierarchy

To configure HQoS, map the level-3 to level-5 hierarchy in multi-level HQoS to a different scheduler to represent it and map it to the physical interface.

Configuration Syntax and Commands

The configurations in this section exemplify the setup of Hierarchical Quality of Service (HQoS) for a subscriber with a residential profile and a Service Level Agreement (SLA) of 20Mbps upstream and downstream. The setup also encompasses four different service types, namely Best Effort(BE), Low-Delay(LD), Low-Loss(LL) and Voice(VO). Different services are assigned to various policer levels for upstream traffic based on their respective traffic classes. Meanwhile, for downstream traffic, these same services are assigned to different queues depending on their traffic class. The traffic class is determined by the configuration of either the BA or MF classifier.

The following sections describe the HQoS configuration syntax and commands.

- Configuring QoS Profiles
- Behavior Aggregate (BA) Classifier Configuration
- Multifield Classifier (MFC) Configuration
- L2 ACL Priority Bit Egress Classifier Configuration
- Policer Configuration
- Class-Policer-Map Configuration
- Queue Configuration
- Queue-Group Configuration

- Class-Queue-Map Configuration
- Scheduler Configuration
- Shaper Configuration
- Scheduler-Map Configuration
- Remark-Map Configuration

6.7. Configuring QoS Profiles

A profile configuration defines the QoS profile that is installed on the subscriber or L3 interfaces. The following sections explain the different elements of the QoS profiles that you can create and attach.

Use the following CLI syntax to configure a QoS profile:

set forwarding-options class-of-service profile <profile-name> <attribute> <value>

Attribute	Description
<profile-name>	Specifies the name of the QoS profile
classifier-name <classifier-name>	Specifies the name of the BA classifier
multifield-classifier-name <multifield-classifier-name>	Specifies the name of the multifield classifier
class-policer-map-name <class-policer-map-name>	Specifies the name of the map that associates a class with a policer level.
policer-name <policer-name>	Specifies the policer name
class-queue-map-name <class-queue-map-name>	Specifies the name of the map that associates a class with a queue
scheduler-map-name <scheduler-map-name>	Specifies the name of the scheduler map
remark-map-name <remark-map-name>	Specifies the name of the remark map

Attribute	Description
egress-class-policer-map-name <egress-class-policer-map-name>	Specifies the name of the egress Class Policer Map. This configuration applies only to the L2X traffic on the LAG interface.
egress-policer-name <egress-policer-name>	Specifies the name of the egress policer. This configuration applies only to the L2X traffic on the LAG interface.

In the following example, the QoS profile residential is configured with classifier-name subs-pbit-class, class-policer-map policer-map-residential, policer policer-residential, class-queue-map subs-4queues, scheduler-map subs-4queues-residential, and remark-map subs-remarking-residential.

```
set forwarding-options class-of-service profile residential
set forwarding-options class-of-service profile residential classifier-name subs-
pbit-class
set forwarding-options class-of-service profile residential class-queue-map-name
subs-4queues
set forwarding-options class-of-service profile residential remark-map-name subs-
remarking-residential
set forwarding-options class-of-service profile residential policer-name policer-
residential
set forwarding-options class-of-service profile residential class-policer-map-name
policer-map-residential
set forwarding-options class-of-service profile residential scheduler-map-name
subs-4queues-residential
commit
```

The following example shows the QoS profile configuration of the residential profile:

```
supervisor@rtbrick>LEAF01: cfg> show config forwarding-options class-of-service
profile
{
  "rtbrick-config:profile": [
    {
      "profile-name": "residential",
      "classifier-name": "subs-pbit-class",
      "class-queue-map-name": "subs-4queues",
      "remark-map-name": "subs-remarking-residential",
      "policer-name": "policer-residential",
      "class-policer-map-name": "policer-map-residential",
      "scheduler-map-name": "subs-4queues-residential"
    }
  ]
}
```

API To access the RESTCONF API that corresponds to this CLI, click here.

Attaching QoS Profile to IFP

This release supports attaching a QoS profile to a physical interface (IFP).

The following guidelines apply for IFP QoS:

- IFP QoS supports global classifier configurations
- Queue statistics for IFP QoS is supported only in the Q2C-based platforms
- IFP QoS does not support the following configurations:

  Per-profile classifier configuration

  Scheduler

  Remarking

  Policer
- IFP QoS is not supported on LAG interfaces on Q2C and Q2A platforms

Attaching QoS Profile to IFP:

Syntax:

set interface <name> **class-of-service** <class-of-service>

Attribute	Description
<name>	Name of the physical interface (IFP).
<class-of-service>	Name of the QoS profile to attach to the IFP.

The following example assigns the QoS profile named qos_profile_1 to the physical interface ifp-0/1/23, configuring how traffic on that interface is prioritized and shaped.

```
set interface ifp-0/1/23 class-of-service qos_profile_1
```

```
{
  "rtbrick-config:interface": [
      "name: "ifp-0/1/23",
      "class-of-service": "qos_profile_1"
  ]
}
```

Behavior Aggregate (BA) Classifier Configuration

Use the following CLI syntax to configure the BA classifier:

set forwarding-options class-of-service classifier <classifier-name> <attribute> <value>

Attribute	Description
<classifier-name>	Specifies the classifier name
match-type <match-type>	Specifies the type of traffic to classify, that is, ipv4-tos, ipv6-tc, ieee-802.1, ieee-802.1-inner, exp
match-type <match-type> codepoint <codepoint>	Specifies the code-point value based on the match-type
match-type <match-type> codepoint <codepoint> class <class>	Specifies the traffic class as class-0, class-1, class-2, class-3, class-4, class-5, class-6, and class-7
match-type <match-type> codepoint <codepoint> remark-codepoint <remark-codepoint>	Specifies the remark-codepoint that is used for remarking

The following example configures the BA classifier subs-pbit-class for traffic ieee-802.1 with a match code point 2 classified as class class-1.

```
set forwarding-options class-of-service classifier subs-pbit-class match-type
ieee-802.1 codepoint 2 class class-1
commit
```



The derived class and the expected codepoint must match for the traffic type being classified.

The following example shows BA classifier configuration.

```
supervisor@rtbrick>LEAF01: cfg> show config forwarding-options class-of-service
classifier
{
  "rtbrick-config:classifier": [
    {
      "classifier-name": "subs-pbit-class",
      "match-type": [
```

```
        {
          "match-type": "ieee-802.1",
          "codepoint": [
            {
              "codepoint": 2,
              "class": "class-1"
            }
          ]
        }
      ]
    }
  ]
}
```

The following configuration sets ieee-802.1-inner classifier match-type.



The inner VLAN P-bit classification feature is available only on the Q2C-based platform.

```
set forwarding-options class-of-service classifier subs-inner-pbit
set forwarding-options class-of-service classifier subs-inner-pbit match-type
ieee-802.1-inner
set forwarding-options class-of-service classifier subs-inner-pbit match-type
ieee-802.1-inner codepoint 2
set forwarding-options class-of-service classifier subs-inner-pbit match-type
ieee-802.1-inner codepoint 2 class class-1
```

The following example shows the configuration for the ieee-802.1-inner classifier match-type.

```
supervisor@rtbrick>: cfg> show config forwarding-options class-of-service
classifier subs-inner-pbit
{
  "rtbrick-config:classifier": [
    {
      "classifier-name": "subs-inner-pbit",
      "match-type": [
        {
          "match-type": "ieee-802.1-inner",
          "codepoint": [
            {
              "codepoint": 2,
              "class": "class-1"
            }
          ]
        }
      ]
    }
  ]
}
```



To access the RESTCONF API that corresponds to this CLI, click here.

Multifield Classifier (MFC) Configuration

Use the following CLI syntax to configure the multifield classifier.

set forwarding-options class-of-service multifield-classifier <attribute> <value>

[NOTE]:

- Starting from Release 20.10.2, Multifield Classifier configuration requires explicit use of ordinal keywords.
- For classification and remarking of best effort upstream traffic, it is recommended to configure an ACL/Classifier that Qualifies the best-effort traffic and updates IP-ToS/IPv6-TC with 0. This ensures that the upstream traffic is marked correctly.

Attribute	Description
acl <l3v4 | l3v6> <...>	Specifies the l3v4 / l3v6 ACL rule for multifield classifier configurations. For more information on configuring the ACL match rules, see the sections below.

API To access the RESTCONF API that corresponds to this CLI, click here.

IPv4 ACL Configuration Configuration

Use the following CLI syntax to configure the IPv4 ACL Match Configuration for the multifield classifier:

set forwarding-options class-of-service multifield-classifier acl l3v4 rule <rule-name> ordinal <ordinal-value> <attribute> <Value>

Attribute	Description
<rule-name>	Specifies the multifield classifier rule name

Attribute	Description
ordinal <ordinal-value>	Specifies the ordinal that is used for traffic policy rule referencing
match <destination-ipv4-prefix>	Specifies the destination IPv4 prefix address
match <destination-ipv4-prefix-list>	Specifies the destination IPv4 prefix list name
match <direction>	Specifies the acl l3 traffic direction match
match <ip-protocol>	Specifies the IP protocol such as UDP or TCP
match <destination-l4-port>	Specifies the Layer 4 destination port number
match <ipv4-tos>	Specifies the IPv4 ToS value
match <ipv4-dscp>	Specifies the IPv4 Differentiated Services Code Point (DSCP) value
match <forward-class>	Specifies the forward class name
match <mpls-traffic>	Specifies the MPLS traffic
match <source-ipv4-prefix>	Specifies the source IPv4 prefix address
match <source-ipv4-prefix-list>	Specifies the source IPv4 prefix list name
match <source-l4-port>	Specifies the Layer 4 source port number
action forward-class <class>	class-0, class-1, class-2, class-3, class-4, class-5, class-6, class-7
action remark-codepoint <remark-codepoint>	Specifies the remark-map codepoint value. Range: 0-254.
action remark-dscp-codepoint <remark-dscp-codepoint>	Specifies the remark DSCP codepoint value. Range: 0-63. To ensure ECN transparency, you must configure the MFC with the remark-dscp-codepoint option. Also, the traffic must match and hit the MFC ACL. Remark code-point (remark-codepoint) and Remark DSCP code-point (remark-dscp-codepoint) are mutually exclusive configurations and cannot be used together.

Multifield classification commonly matches on IP address fields, the IP protocol

type field, or the port number in the UDP or TCP pseudo-header field.

The l3v4 acl-type multifield classifier is configured with a qualifier/match based on ipv4-tos (128, 160) and source-ipv4-prefix (132.1.1.3/32) with action as forward-class (class-0,class-1).

```
set forwarding-options class-of-service multifield-classifier acl l3v4 rule
global_mfc
set forwarding-options class-of-service multifield-classifier acl l3v4 rule
global_mfc ordinal 1001
set forwarding-options class-of-service multifield-classifier acl l3v4 rule
global_mfc ordinal 1001 match ipv4-tos 128
set forwarding-options class-of-service multifield-classifier acl l3v4 rule
global_mfc ordinal 1001 match source-ipv4-prefix 132.1.1.3/32
set forwarding-options class-of-service multifield-classifier acl l3v4 rule
global_mfc ordinal 1001 action forward-class class-0
set forwarding-options class-of-service multifield-classifier acl l3v4 rule
global_mfc ordinal 1002
set forwarding-options class-of-service multifield-classifier acl l3v4 rule
global_mfc ordinal 1002 match ipv4-tos 160
set forwarding-options class-of-service multifield-classifier acl l3v4 rule
global_mfc ordinal 1002 match source-ipv4-prefix 132.1.1.3/32
set forwarding-options class-of-service multifield-classifier acl l3v4 rule
global_mfc ordinal 1002 action forward-class class-1
commit
```

The following example shows the IPv4 Match Configuration for the multifield classifier:

```
supervisor@rtbrick.net: cfg> show config forwarding-options class-of-service
multifield-classifier acl l3v4 rule global_mfc
{
    "rtbrick-config:rule": [
      {
        "rule-name": "global_mfc",
        "ordinal": [
          {
            "ordinal-value": 1001,
            "match": {
              "ipv4-tos": 128,
              "source-ipv4-prefix": "132.1.1.3/32"
            },
            "action": {
              "forward-class": "class-0"
            }
          },
          {
            "ordinal-value": 1002,
            "match": {
              "ipv4-tos": 160,
              "source-ipv4-prefix": "132.1.1.3/32"
            },
            "action": {
              "forward-class": "class-1"
            }
```

```
        }
      ]
    }
  ]
}
```

To access the RESTCONF API that corresponds to this CLI, click here.

IPv6 ACL Configuration Configuration

Use the following CLI syntax to configure the IPv6 ACL match configuration for the multifield classifier:

set forwarding-options class-of-service multifield-classifier acl l3v6 rule <rule-name> ordinal <ordinal-value> <attribute> <value>

Attribute	Description
<rule-name>	Specifies the multifield classifier rule name
ordinal <ordinal-value>	Specifies the ordinal that is used for traffic rule referencing
match <destination-ipv6-prefix>	Specifies the destination IPv6 prefix address
match <destination-ipv6-prefix-list>	Specifies the destination IPv6 prefix list name
match <ip-protocol>	Specifies the IP protocol such as UDP or TCP
match <destination-l4-port>	Specifies the Layer 4 destination port number
match <ipv6-tc>	Specifies the IPv6 traffic class value
match <forward-class>	Specifies the forward class name
match <mpls-traffic>	Specifies the MPLS traffic
match <source-ipv6-prefix>	Specifies the source IPv6 prefix address
match <source-ipv6-prefix-list>	Specifies the source IPv6 prefix list name
match <source-l4-port>	Specifies the Layer 4 source port number

Attribute	Description
action forward-class <class>	class-0, class-1, class-2, class-3, class-4, class-5, class-6, class-7
action remark-codepoint <remark-codepoint>	Specifies the remark-map codepoint value. Range: 0-254.
action remark-dscp-codepoint <remark-dscp-codepoint>	Specifies the remark DSCP codepoint value. Range: 0-63.

In the following example, the l3v6 acl-type multifield classifier is configured with qualifier/match based on ipv6-tc (128, 160) and source-ipv6-prefix (132:1:1::3/32) with action as forward-class (class-0,class-1).

```
set forwarding-options class-of-service multifield-classifier acl l3v6 rule global_mfc
set forwarding-options class-of-service multifield-classifier acl l3v6 rule global_mfc ordinal 1001
set forwarding-options class-of-service multifield-classifier acl l3v6 rule global_mfc ordinal 1001 match
ipv6-tc 128
set forwarding-options class-of-service multifield-classifier acl l3v6 rule global_mfc ordinal 1001 match
source-ipv6-prefix 132::1::3/32
set forwarding-options class-of-service multifield-classifier acl l3v6 rule global_mfc ordinal 1001 action
forward-class class-0
set forwarding-options class-of-service multifield-classifier acl l3v6 rule global_mfc ordinal 1002
set forwarding-options class-of-service multifield-classifier acl l3v6 rule global_mfc ordinal 1002 match
ipv6-tc 160
set forwarding-options class-of-service multifield-classifier acl l3v6 rule global_mfc ordinal 1002 match
source-ipv6-prefix 132:1:1::3/32
set forwarding-options class-of-service multifield-classifier acl l3v6 rule global_mfc ordinal 1002 action
forward-class class-1
commit
```

The following example shows the IPv6 match configuration for the multifield classifier:

```
supervisor@rtbrick.net: cfg> show config forwarding-options class-of-service multifield-classifier acl l3v6
rule global_mfc
{
    "rtbrick-config:rule": [
      {
        "rule-name": "global_mfc",
        "ordinal": [
          {
            "ordinal-value": 1001,
            "match": {
              "ipv6-tc": 128,
              "source-ipv6-prefix": "132:1:1::3/32"
            },
            "action": {
              "forward-class": "class-0"
            }
          },
          {
            "ordinal-value": 1002,
            "match": {
              "ipv6-tc": 160,
              "source-ipv6-prefix": "132:1:1::3/32"
            },
            "action": {
```

```
            "forward-class": "class-1"
          }
        }
      ]
    }
  ]
}
```

To access the RESTCONF API that corresponds to this CLI, click here.

IPv4/IPv6 Priority Configuration

Use the following CLI syntax to configure the IPv4/IPv6 priority configuration:

set forwarding-options class-of-service multifield-classifier acl [**l3v4** | **l3v6**] **rule** <rule-name> <attribute> <value>

Attribute	Description
<rule-name>	Specifies the multifield classifier rule name.
ordinal <ordinal-value>	Specifies the ordinal that is used for traffic policy rule referencing.
ordinal <ordinal-value> <priority>	Specify the ACL priority value. Range: 100-20000. The default priority value for multifield-classifier ACL is 500.

The following example configures the l3v6 acl-type multifield classifier with qualifier/match based on ipv6-tc (128) and source-ipv6-prefix(132:1:1::3/32) with action as forward-class (class-0,class-1) along with priority value (100, 200). When there are multiple qualifiers or actions, the one with the higher priority takes precedence over the others.

```
set forwarding-options class-of-service multifield-classifier acl l3v6 rule global_mfc
set forwarding-options class-of-service multifield-classifier acl l3v6 rule global_mfc ordinal 1001
set forwarding-options class-of-service multifield-classifier acl l3v6 rule global_mfc ordinal 1001 match
ipv6-tc 128
set forwarding-options class-of-service multifield-classifier acl l3v6 rule global_mfc ordinal 1001 match
source-ipv6-prefix 132::1::3/32
set forwarding-options class-of-service multifield-classifier acl l3v6 rule global_mfc ordinal 1001 priority
100
set forwarding-options class-of-service multifield-classifier acl l3v6 rule global_mfc ordinal 1001 action
forward-class class-0
set forwarding-options class-of-service multifield-classifier acl l3v6 rule global_mfc ordinal 1002
set forwarding-options class-of-service multifield-classifier acl l3v6 rule global_mfc ordinal 1002 match
ipv6-tc 128
set forwarding-options class-of-service multifield-classifier acl l3v6 rule global_mfc ordinal 1002 match
source-ipv6-prefix 132:1:1::3/32
set forwarding-options class-of-service multifield-classifier acl l3v6 rule global_mfc ordinal 1002 priority
200
set forwarding-options class-of-service multifield-classifier acl l3v6 rule global_mfc ordinal 1002 action
```

```
forward-class class-1
commit
```

The following example shows the IPv4 priority configuration:

```
supervisor@rtbrick>LEAF01: cfg> show config forwarding-options class-of-service multifield-classifier acl
l3v4 rule rtb_mfc


supervisor@rtbrick.net: cfg> show config forwarding-options class-of-service multifield-classifier acl l3v6
rule global_mfc
{
    "rtbrick-config:rule": [
      {
        "rule-name": "global_mfc",
        "ordinal": [
          {
            "ordinal-value": 1001,
            "priority": 100,
            "match": {
              "ipv6-tc": 128,
              "source-ipv6-prefix": "132:1:1::3/32"
            },
            "action": {
              "forward-class": "class-0"
            }
          },
          {
            "ordinal-value": 1002,
            "priority": 200,
            "match": {
              "ipv6-tc": 160,
              "source-ipv6-prefix": "132:1:1::3/32"
            },
            "action": {
              "forward-class": "class-1"
            }
          }
        ]
      }
    ]
  }
```

API To access the RESTCONF API that corresponds to this CLI, click here.

6.7.1. L2 ACL Priority Bit Egress Classifier Configuration

Use the following CLI syntax to configure the L2 ACL priority bit egress classifier.

set forwarding-options <attribute> <value>

Attribute	Description
acl l2 <...>	Specifies the l2 ACL rule for egress priority bit classifier configurations. For more information on configuring the ACL match rules, see the sections below.

Service VLAN Priority Configuration

Use the following CLI syntax to configure the L2 ACL Match Configuration for the egress priority bit classifier:

set forwarding-options acl l2 rule <rule-name> ordinal <ordinal-value> <attribute> <Value>

Attribute	Description
<rule-name>	Specifies the L2 ACL classifier rule name
ordinal <ordinal-value>	Specifies the ordinal that is used for traffic rule referencing
match <direction>	Specifies the direction of L2 traffic
match <service-outer-vlan-priority>	Specifies the outer VLAN priority of the L2 service traffic
action forward-class <class>	class-0, class-1, class-2, class-3, class-4, class-5, class-6, class-7

L2 ACL classification commonly matches on layer-2 fields such as service-inner-vlan-priority, service-outer-vlan-priority, interface-meta-data, and direction

The l2 acl type egress priority bit classifier is configured with a qualifier/match based on service-inner-vlan-priority ` (0-7), interface-meta-data (type-1), direction (ingress), service-outer-vlan-priority (0-7) with action as forward-class (class-0 to class-7).

```
set forwarding-options acl l2 rule evpn_vpws ordinal 0
set forwarding-options acl l2 rule evpn_vpws ordinal 0 match direction ingress
set forwarding-options acl l2 rule evpn_vpws ordinal 0 match service-outer-vlan-priority 0
set forwarding-options acl l2 rule evpn_vpws ordinal 0 match interface-meta-data type-1
set forwarding-options acl l2 rule evpn_vpws ordinal 0 action forward-class class-0
set forwarding-options acl l2 rule evpn_vpws ordinal 1
set forwarding-options acl l2 rule evpn_vpws ordinal 1 match direction ingress
```

```
set forwarding-options acl l2 rule evpn_vpws ordinal 1 match service-outer-vlan-priority 1
set forwarding-options acl l2 rule evpn_vpws ordinal 1 match interface-meta-data type-1
set forwarding-options acl l2 rule evpn_vpws ordinal 1 action forward-class class-1
commit
```

The following example shows the L2 ACL P-Bit Egress Classifier configuration:

```
supervisor@rtbrick>multiservice-edge.rtbrick.net: cfg> show config forwarding-options acl l2 rule evpn_vpws
ordinal
{
  "rtbrick-config:ordinal": [
    {
      "ordinal-value": 0,
      "match": {
        "direction": "ingress",
        "service-outer-vlan-priority": 0,
        "interface-meta-data": "type-1"
      },
      "action": {
        "forward-class": "class-0"
      }
    },
    {
      "ordinal-value": 1,
      "match": {
        "direction": "ingress",
        "service-outer-vlan-priority": 1,
        "interface-meta-data": "type-1"
      },
      "action": {
        "forward-class": "class-1"
      }
    }
  ]
}
```

API To access the RESTCONF API that corresponds to this CLI, click here.

Policer Configuration

Use the following CLI syntax to configure the QoS policer:

set forwarding-options class-of-service policer <policer-name> <attribue> <value>

Attribute	Description
<policer-name>	Specifies the policer name.

Attribute	Description
levels <levels>	Specifies levels in the policer. There is only support for the policer levels 1 and 4.  If the QoS policer levels is set to 1, the rate configuration for levels 2, 3, and 4 is blocked. Changing levels from 4 to 1 also blocks the configuration, unless only one level rate is set.
type <type>	Specifies the policer type.
flags <flag>	Specifies the policer flags.
level1-rates cir <cir>	Specifies the committed information rate (CIR) in Kilobits per second (Kbps) for level-1. The same is applicable for level-2 to level-4.
level1-rates pir <pir>	Specifies the peak information rate (PIR) in Kilobits per second (Kbps) for level-1. The same is applicable for level-2 to level-4.
level1-rates cbs <cbs>	Specifies the Committed burst size (CBS) in Kilobits per second (Kbps) for level-1. The same is applicable for level-2 to level-4.
level1-rates pbs <pbs>	Specifies the peak burst size (PBS) in Kilobits per second (Kbps) for level-1. The same is applicable for level-2 to level-4.
level1-rates max-cir <max-cir>	Specifies the maximum for the level-1 committed information rate (CIR) in kilobits per second (Kbps). The same is applicable for level-2 to level-4.
level1-rates max-pir <max-pir>	Specifies the maximum for the level-1 peak information rate (PIR) in Kilobits per second (Kbps). The same is applicable for level-2 to level-4.

Attribute	Description
mode <single-level | large-bucket | single-level-large-bucket>	Specifies the mode of the QoS policer. Supported modes: large-bucket, single-level, and single-level-large-bucket. The Committed burst size (CBS) and Peak burst size(PBS) can be specified in the range 0-2088960 (kbits). The burst size of the policer is configurable up to 4 MB in regular mode. The large-bucket mode allows the configuration of buckets ranging from 4 MB to 255 MB. Operating in large-bucket mode may reduce the policer rate accuracy.

The following example configures the QoS policer policer-residential with multi-level policers (levels=4), CIR, PIR rates, and burst sizes (CBS, PBS) for each level (level-1, level-2, level-3 and level-4). Also, two-rate-three-color policer type and color-blind as the default configuration. The four-level Policer configuration is as follows:

- Level-1(cir=2Mbps, pir=2.5Mbps, cbs=1000, pbs=1000)
- Level-2(cir=3Mbps, pir=3.5Mbps, cbs=1000, pbs=1000)
- Level-3(cir=4Mbps, pir=4.5Mbps, cbs=1000, pbs=1000)
- Level-4(cir=1Mbps, pir=1.5Mbps, cbs=1000, pbs=1000)

The following configurations show policer configurations for levels=4.

```
set forwarding-options class-of-service policer policer-residential
set forwarding-options class-of-service policer policer-residential level1-rates cir 2000
set forwarding-options class-of-service policer policer-residential level1-rates cbs 1000
set forwarding-options class-of-service policer policer-residential level1-rates pir 2500
set forwarding-options class-of-service policer policer-residential level1-rates pbs 1000
set forwarding-options class-of-service policer policer-residential level2-rates cir 3000
set forwarding-options class-of-service policer policer-residential level2-rates cbs 1000
set forwarding-options class-of-service policer policer-residential level2-rates pir 3500
set forwarding-options class-of-service policer policer-residential level2-rates pbs 1000
set forwarding-options class-of-service policer policer-residential level3-rates cir 4000
set forwarding-options class-of-service policer policer-residential level3-rates cbs 1000
set forwarding-options class-of-service policer policer-residential level3-rates pir 4500
set forwarding-options class-of-service policer policer-residential level3-rates pbs 1000
set forwarding-options class-of-service policer policer-residential level4-rates cir 1000
set forwarding-options class-of-service policer policer-residential level4-rates cbs 1000
set forwarding-options class-of-service policer policer-residential level4-rates pir 1500
set forwarding-options class-of-service policer policer-residential level4-rates pbs 1000
```

```
set forwarding-options class-of-service policer policer-residential levels 4
set forwarding-options class-of-service policer policer-residential type two-rate-three-color
commit
```

The following example shows the QoS policer level (levels=4) rates configuration:

```
supervisor@rtbrick>LEAF01: cfg> show config forwarding-options class-of-service policer policer-residential
{
  "rtbrick-config:policer": [
{
            "policer-name": "policer-residential",
            "level1-rates": {
              "cir": 2000,
              "cbs": 1000,
              "pir": 2500,
              "pbs": 1000
            },
            "level2-rates": {
              "cir": 3000,
              "cbs": 1000,
              "pir": 3500,
              "pbs": 1000
            },
            "level3-rates": {
              "cir": 4000,
              "cbs": 1000,
              "pir": 4500,
              "pbs": 1000
            },
            "level4-rates": {
              "cir": 1000,
              "cbs": 1000,
              "pir": 1500,
              "pbs": 1000
            },
            "levels": 4,
            "type": "two-rate-three-color"
          }
  ]
}
```

The following configurations show policer configurations for levels=1.

```
set forwarding-options class-of-service policer policer-residential
set forwarding-options class-of-service policer policer-residential level1-rates cir 2000
set forwarding-options class-of-service policer policer-residential level1-rates cbs 1000
set forwarding-options class-of-service policer policer-residential level1-rates pir 2500
set forwarding-options class-of-service policer policer-residential level1-rates pbs 1000
set forwarding-options class-of-service policer policer-residential levels 1
set forwarding-options class-of-service policer policer-residential type two-rate-three-color
commit
```

The following example shows the QoS policer level rates (levels=1) configuration:

```
supervisor@rtbrick>LEAF01: cfg> show config forwarding-options class-of-service policer policer-residential
{
  "rtbrick-config:policer": [
{
            "policer-name": "policer-residential",
            "level1-rates": {
              "cir": 2000,
              "cbs": 1000,
```

```
              "pir": 2500,
              "pbs": 1000
            }
            "levels": 1,
            "type": "two-rate-three-color"
          }
  ]
}
```

The following example shows the Large Bucket mode configuration in QoS Policer.

```
set forwarding-options class-of-service policer policer-residential
set forwarding-options class-of-service policer policer-residential level1-rates
set forwarding-options class-of-service policer policer-residential level1-rates cir 700000000
set forwarding-options class-of-service policer policer-residential level1-rates cbs 2088960
set forwarding-options class-of-service policer policer-residential level1-rates pir 700000000
set forwarding-options class-of-service policer policer-residential level1-rates pbs 2088960
set forwarding-options class-of-service policer policer-residential level2-rates
set forwarding-options class-of-service policer policer-residential level2-rates cir 3000
set forwarding-options class-of-service policer policer-residential level2-rates cbs 1000
set forwarding-options class-of-service policer policer-residential level2-rates pir 3500
set forwarding-options class-of-service policer policer-residential level2-rates pbs 1000
set forwarding-options class-of-service policer policer-residential level3-rates
set forwarding-options class-of-service policer policer-residential level3-rates cir 4000
set forwarding-options class-of-service policer policer-residential level3-rates cbs 1000
set forwarding-options class-of-service policer policer-residential level3-rates pir 4500
set forwarding-options class-of-service policer policer-residential level3-rates pbs 1000
set forwarding-options class-of-service policer policer-residential level4-rates
set forwarding-options class-of-service policer policer-residential level4-rates cir 1000
set forwarding-options class-of-service policer policer-residential level4-rates cbs 1000
set forwarding-options class-of-service policer policer-residential level4-rates pir 1500
set forwarding-options class-of-service policer policer-residential level4-rates pbs 1000
set forwarding-options class-of-service policer policer-residential levels 4
set forwarding-options class-of-service policer policer-residential type two-rate-three-color
set forwarding-options class-of-service policer policer-residential mode large-bucket
```

 To access the RESTCONF API that corresponds to this CLI, click here.

6.7.2. Class-Policer-Map Configuration

Use the following CLI syntax to configure the Class-Policer-Map:

set forwarding-options class-of-service class-policer-map <class-policer-map-name> <attribue> <value>

Attribute	Description
<class-policer-map-name>	Specifies the class policer map name,
class <class>	Specifies the class such as class-0, class-1, class-2, class-3, class-4, class-5, class-6, class-7

Attribute	Description
class <class> <policer-level>	Specifies the policer levels. The supported levels are: level-1, level-2, level-3, and level-4

Below is an example configuration of the class-policer-map, which sets up level-1 to level-4 policer levels.

- class-0 mapped to policer level-1
- class-1 mapped to policer level-2
- class-2 mapped to policer level-3
- class-3 mapped to policer level-4

```
set forwarding-options class-of-service class-policer-map policer-map-residential class class-0 policer-level
level-1
set forwarding-options class-of-service class-policer-map policer-map-residential class class-1 policer-level
level-2
set forwarding-options class-of-service class-policer-map policer-map-residential class class-2 policer-level
level-3
set forwarding-options class-of-service class-policer-map policer-map-residential class class-3 policer-level
level-4
commit
```

The following example shows the class-policer-map configuration:

```
supervisor@rtbrick>LEAF01: cfg> show config forwarding-options class-of-service class-policer-map policer-
map-l2tp
{
  "rtbrick-config:class-policer-map": [
{
            "class-policer-map-name": "policer-map-residential",
            "class": [
              {
                "class": "class-0",
                "policer-level": "level-1"
              },
              {
                "class": "class-1",
                "policer-level": "level-2"
              },
              {
                "class": "class-2",
                "policer-level": "level-3"
              },
              {
                "class": "class-3",
                "policer-level": "level-4"
              }
            ]
          }
  ]
}
```

API To access the RESTCONF API that corresponds to this CLI, click here.

Queue Configuration

Use the following CLI syntax to configure a queue:

set forwarding-options class-of-service queue <queue-name> <atribute> <value>

Attribute	Description
<queue-name>	Specifies the queue name
queue-size <queue-size>	Specifies the size of the queue in bytes
<shaper-name>	(Optional) Specifies the shaper that is associated with the queue.
wred minimum-threshold <minimum-threshold>	Specifies the minimum average queue size to apply WRED in bytes
wred maximum-threshold <maximum-threshold>	Specifies the maximum average queue size to apply WRED in bytes
wred drop-probability <drop-probability>	WRED drop probability applied at the maximum threshold
header-compensation bytes <bytes>	Specifies the header compensation value
header-compensation decrement true	Specifies whether the header compensation value is to be decremented.

The following example configures four queues with different traffic streams named BE_SUBS, LD_SUBS, LL_SUBS and VO_SUBS with queue attributes queue-size, queue header-compensation & queue shaper for Best Effort(BE), Low-Delay(LD), Low-Loss(LL) and Voice(VO) Queues.

```
set forwarding-options class-of-service queue BE_SUBS
set forwarding-options class-of-service queue BE_SUBS queue-size 375000
set forwarding-options class-of-service queue BE_SUBS header-compensation bytes 22
set forwarding-options class-of-service queue BE_SUBS header-compensation decrement true
set forwarding-options class-of-service queue LD_SUBS
set forwarding-options class-of-service queue LD_SUBS queue-size 625000
set forwarding-options class-of-service queue LD_SUBS header-compensation bytes 22
set forwarding-options class-of-service queue LD_SUBS header-compensation decrement true
set forwarding-options class-of-service queue LL_SUBS
set forwarding-options class-of-service queue LL_SUBS queue-size 625000
set forwarding-options class-of-service queue LL_SUBS header-compensation bytes 22
set forwarding-options class-of-service queue LL_SUBS header-compensation decrement true
```

```
set forwarding-options class-of-service queue VO_SUBS
set forwarding-options class-of-service queue VO_SUBS queue-size 156250
set forwarding-options class-of-service queue VO_SUBS header-compensation bytes 22
set forwarding-options class-of-service queue VO_SUBS header-compensation decrement true
set forwarding-options class-of-service queue VO_SUBS shaper-name shaper_VO
commit
```

The following example shows the queue configuration:

```
supervisor@DT-STD-23-2402>bm14-tst.fsn.rtbrick.net: cfg> show config forwarding-options class-of-service
queue
{
  "rtbrick-config:queue": [
{
            "queue-name": "BE_SUBS",
            "queue-size": 375000,
            "header-compensation": {
              "bytes": 22,
              "decrement": "true"
            }
          },
          {
            "queue-name": "LD_SUBS",
            "queue-size": 625000,
            "header-compensation": {
              "bytes": 22,
              "decrement": "true"
            }
          },
          {
            "queue-name": "LL_SUBS",
            "queue-size": 625000,
            "header-compensation": {
              "bytes": 22,
              "decrement": "true"
            }
          },
          {
            "queue-name": "VO_SUBS",
            "queue-size": 156250,
            "shaper-name": "shaper_VO",
            "header-compensation": {
              "bytes": 22,
              "decrement": "true"
            }
          }
  ]
}
```

API To access the RESTCONF API that corresponds to this CLI, click here.

Queue-Group Configuration

Queue group size: 1 or 4 or 8

Use the following CLI syntax to configure a queue group:

set forwarding-options class-of-service queue-group <queue-group-name> <attribute> <value>

Attribute	Description
<queue-group-name>	User-defined name for the queue-group
queue-numbers <queue-numbers>	Specifies the number of queues in a Queue Group

The following examples configure the queue group with queue numbers 1 and 4.

```
set forwarding-options class-of-service queue-group subs-4queues queue-numbers 1
commit
```

The following example shows the queue group configuration:

```
supervisor@rtbrick>LEAF01: cfg> show config forwarding-options class-of-service queue-group
{
  "rtbrick-config:queue-group": [
    {
      "queue-group-name": "subs-4queues",
      "queue-numbers": 1
    }
  ]
}
```

```
set forwarding-options class-of-service queue-group subs-4queues queue-numbers 4
```

The following example shows the queue group configuration:

```
supervisor@rtbrick>LEAF01: cfg> show config forwarding-options class-of-service queue-group
{
  "rtbrick-config:queue-group": [
    {
      "queue-group-name": "subs-4queues",
      "queue-numbers": 4
    }
  ]
}
```

API To access the RESTCONF API that corresponds to this CLI, click here.

Class-Queue-Map Configuration

Use the following CLI syntax to configure the class-queue-map:

set forwarding-options class-of-service class-queue-map <class-queue-

```
map-name> <attribute> <value>
```

Attribute	Description
<class-queue-map-name>	Specifies the class queue map name
class <class>	Specifies the class such as class-0, class-1, class-2, class-3, class-4, class-5, class-6, class-7
class <class> queue-name <queue-name>	Specifies the queue name

The following example configures the class-queue-map for the specific classes and queues:

- class-0 mapped to queue BE_SUBS
- class-1 mapped to queue LD_SUBS
- class-2 mapped to queue LL_SUBS
- class-3 mapped to queue VO_SUBS

```
set forwarding-options class-of-service class-queue-map subs-4queues class class-0 queue-name BE_SUBS
set forwarding-options class-of-service class-queue-map subs-4queues class class-1 queue-name LD_SUBS
set forwarding-options class-of-service class-queue-map subs-4queues class class-2 queue-name LL_SUBS
set forwarding-options class-of-service class-queue-map subs-4queues class class-3 queue-name VO_SUBS
commit
```

The following example shows the class-queue-map configuration:

```
supervisor@rtbrick>LEAF01: cfg> show config forwarding-options class-of-service class-queue-map
{
  "rtbrick-config:class-queue-map": [
{
            "class-queue-map-name": "subs-4queues",
            "class": [
              {
                "class-type": "class-0",
                "queue-name": "BE_SUBS"
              },
              {
                "class-type": "class-1",
                "queue-name": "LD_SUBS"
              },
              {
                "class-type": "class-2",
                "queue-name": "LL_SUBS"
              },
              {
                "class-type": "class-3",
                "queue-name": "VO_SUBS"
              }
            ]
```

```
        }
  ]
}
```

API To access the RESTCONF API that corresponds to this CLI, click here.

Scheduler Configuration

Use the following CLI syntax to configure a scheduler:

set forwarding-options class-of-service scheduler <attribue> <value>

Attribute	Description
<scheduler-name>	User-defined Scheduler Name
<scheduler-name> shaper-name <shaper-name>	(Optional) User-defined Shaper Name
<scheduler-name> type <type>	Specifies the Scheduler Type 2sp_wfq_discrete 3sp_wfq_discrete strict_priority wfq_discrete_2sp 2sp_wfq_independent fair_queueing weighted_fair_queueing wfq_independent_2sp
<scheduler-name> composite true	(Optional) keyword to specify the scheduler as composite type

The following example configures two schedulers: subs-4queues with scheduler type strict_priority for the Subscriber level, and pon0 with scheduler type fair_queueing for PON/GPON level.

```
set forwarding-options class-of-service scheduler subs-4queues
set forwarding-options class-of-service scheduler subs-4queues shaper shaper_session
set forwarding-options class-of-service scheduler subs-4queues type strict_priority
set forwarding-options class-of-service scheduler pon0
set forwarding-options class-of-service scheduler pon0 type fair_queueing
commit
```

The following example shows the QoS scheduler configuration:

```
supervisor@rtbrick>LEAF01: cfg> show config forwarding-options class-of-service scheduler
{
  "rtbrick-config:scheduler": [
          {
            "scheduler-name": "pon0",
            "type": "fair_queueing"
          },
          {
            "scheduler-name": "subs-4queues",
            "shaper-name": "shaper_session",
            "type": "strict_priority"
          }
  ]
}
```

API To access the RESTCONF API that corresponds to this CLI, click here.

Priority Propagation

Use the following CLI syntax to configure priority propagation:

set forwarding-options class-of-service global priority-propagation [**enable** | **disable**]

The following example enables priority propagation at the global level to operate schedulers in dual-flow mode, with high-priority and low-priority flows.

```
set forwarding-options class-of-service global priority-propagation enable
```

The following example shows the priority propagation:

```
supervisor@rtbrick>LEAF01: cfg> show config forwarding-options class-of-service global
{
  "rtbrick-config:global": {
    "priority-propagation": "enable"
  }
}
```

Shaper Configuration

Use the following CLI syntax to configure a shaper:

set forwarding-options class-of-service shaper <shaper-name> <attribue> <value>

Command Arguments

Attribute	Description
<shaper-name>	User-defined shaper name
<shaper-name> shaping-rate-high <0-700000000>	High flow shaping rate in kilobits per second
<shaper-name> shaping-rate-high-precision true	Configures the precision of high-flow shapers, which can only be used with session shapers.
<shaper-name> shaping-rate-low <0-700000000>	Low flow shaping rate in kilobits per second



- Low-rate shaping is only supported for high-priority flows. Enabling low-rate shaping consumes additional QoS resources, which will impact the scalability.
- If priority propagation is not enabled, high-flow shaping value will be considered for shaper.
- If the scheduler type is strict_priority, the mapping of queues to priorities begins with strict_priority_1.
- Shaper rate may not be accurate for fragmented data traffic.

The following example configures the shaper high-flow and low-flow rates for Subscriber Session Level with shaper-name shaper_session and Queue Level with shaper-name shaper_VO.

```
set forwarding-options class-of-service shaper shaper_session
set forwarding-options class-of-service shaper shaper_session shaping-rate-high 10000
set forwarding-options class-of-service shaper shaper_session shaping-rate-low 100
set forwarding-options class-of-service shaper shaper_VO
set forwarding-options class-of-service shaper shaper_VO shaping-rate-high 2000
set forwarding-options class-of-service shaper shaper_VO shaping-rate-low 0
commit
```

The following example shows the shaper configuration:

```
supervisor@rtbrick>LEAF01: cfg> show config forwarding-options class-of-service shaper
{
  "rtbrick-config:shaper": [
          {
            "shaper-name": "shaper_VO",
            "shaping-rate-high": 2000,
            "shaping-rate-low": 0
          },
          {
            "shaper-name": "shaper_session",
            "shaping-rate-high": 10000,
            "shaping-rate-low": 100
          }
  ]
}
```

With the following shaper configuration, the low flow is limited to 1Mbps and the high flow is limited to 512Kbps. This results in a session rate of approximately 1.5Mbps when 10Mbps is distributed between high and low flows.

```
set forwarding-options class-of-service shaper session-shaper
set forwarding-options class-of-service shaper session-shaper shaping-rate-high-
precision true
set forwarding-options class-of-service shaper session-shaper shaping-rate-high
512
set forwarding-options class-of-service shaper session-shaper shaping-rate-low
1000
```

The following example shows the shaper configuration, where the high precision shaping is enabled:

```
{
  "rtbrick-config:shaper": [
    {
      "shaper-name": "session-shaper",
      "shaping-rate-high": 512,
      "shaping-rate-high-precision": "true",
      "shaping-rate-low": 1000
   }
  ]
}
```

API To access the RESTCONF API that corresponds to this CLI, click here.

Scheduler-Map Configuration

Use the following CLI syntax to configure a Scheduler-Map:

set forwarding-options class-of-service scheduler-map <scheduler-map-name> <attribue> <value>

Command arguments

Attribute	Description
<scheduler-map-name>	Specifies the name of the scheduler-map
scheduler-name <scheduler-name>	Specifies the name of the scheduler
queue-group-name <group-name>	Specifies the name of the queue-group
queue-group-name <group-name> queue-name <name>	Specifies the name of the queue
queue-group-name <group-name> queue-name <name> connection-point <connection-point>	Specifies the type of connection point, such as no_priority, strict_priority_0, strict_priority_1, strict_priority_2, strict_priority
queue-group-name <group-name> queue-name <name> parent-flow <high-flow \/ low-flow>	(Optional) Specifies the type of the parent flow, that is high-flow or low-flow.
queue-group-name <group-name> queue-name <name> parent-scheduler-name <parent-scheduler-name>	Specifies the name of the parent scheduler

Attribute	Description
queue-group-name <group-name> queue-name <name> port-connection <port-connection-type>	Specifies the type of port connection, that is, queue_to_port or scheduler_to_port
queue-group-name <group-name> queue-name <name> weight <weight>	Specifies a scheduling weight for the specified queue.

The following example configures a scheduler map for OLT with schedmap-olt and for subscribers with subs-4queues-residential. OLT scheduler-map schedmap-olt is directly connected to the physical port and subs-4queues-residential connects different queues (BE_SUBS, LL_SUBS,LD_SUBS,VO_SUBS) with different connection-points(strict_priority_3, strict_priority_2, strict_priority_1, strict_priority_0).

```
set forwarding-options class-of-service scheduler-map schedmap-olt
set forwarding-options class-of-service scheduler-map schedmap-olt scheduler-name pon0
set forwarding-options class-of-service scheduler-map schedmap-olt scheduler-name pon0 port-connection
scheduler_to_port
set forwarding-options class-of-service scheduler-map subs-4queues-residential
set forwarding-options class-of-service scheduler-map subs-4queues-residential queue-group-name subs-4queues
set forwarding-options class-of-service scheduler-map subs-4queues-residential queue-group-name subs-4queues
queue-name BE_SUBS
set forwarding-options class-of-service scheduler-map subs-4queues-residential queue-group-name subs-4queues
queue-name BE_SUBS parent-flow high-flow
set forwarding-options class-of-service scheduler-map subs-4queues-residential queue-group-name subs-4queues
queue-name BE_SUBS parent-scheduler-name subs-4queues
set forwarding-options class-of-service scheduler-map subs-4queues-residential queue-group-name subs-4queues
queue-name BE_SUBS connection-point strict_priority_3
set forwarding-options class-of-service scheduler-map subs-4queues-residential queue-group-name subs-4queues
queue-name LD_SUBS
set forwarding-options class-of-service scheduler-map subs-4queues-residential queue-group-name subs-4queues
queue-name LD_SUBS parent-flow high-flow
set forwarding-options class-of-service scheduler-map subs-4queues-residential queue-group-name subs-4queues
queue-name LD_SUBS parent-scheduler-name subs-4queues
set forwarding-options class-of-service scheduler-map subs-4queues-residential queue-group-name subs-4queues
queue-name LD_SUBS connection-point strict_priority_1
set forwarding-options class-of-service scheduler-map subs-4queues-residential queue-group-name subs-4queues
queue-name LL_SUBS
set forwarding-options class-of-service scheduler-map subs-4queues-residential queue-group-name subs-4queues
queue-name LL_SUBS parent-flow high-flow
set forwarding-options class-of-service scheduler-map subs-4queues-residential queue-group-name subs-4queues
queue-name LL_SUBS parent-scheduler-name subs-4queues
set forwarding-options class-of-service scheduler-map subs-4queues-residential queue-group-name subs-4queues
queue-name LL_SUBS connection-point strict_priority_2
set forwarding-options class-of-service scheduler-map subs-4queues-residential queue-group-name subs-4queues
queue-name VO_SUBS
set forwarding-options class-of-service scheduler-map subs-4queues-residential queue-group-name subs-4queues
queue-name VO_SUBS parent-flow high-flow
set forwarding-options class-of-service scheduler-map subs-4queues-residential queue-group-name subs-4queues
queue-name VO_SUBS parent-scheduler-name subs-4queues
set forwarding-options class-of-service scheduler-map subs-4queues-residential queue-group-name subs-4queues
```

```
queue-name VO_SUBS connection-point strict_priority_0
set forwarding-options class-of-service scheduler-map subs-4queues-residential scheduler-name subs-4queues
set forwarding-options class-of-service scheduler-map subs-4queues-residential scheduler-name subs-4queues
port-connection scheduler_to_port
commit
```

The following example shows the scheduler-map configuration:

```
supervisor@rtbrick>LEAF01: cfg> show config forwarding-options class-of-service scheduler-map
{
  "rtbrick-config:scheduler-map": [
{
            "scheduler-map-name": "schedmap-olt",
            "scheduler-name": [
              {
                "name": "pon0",
                "port-connection": "scheduler_to_port"
              }
            ]
          },
          {
            "scheduler-map-name": "subs-4queues-residential",
            "queue-group-name": [
              {
                "group-name": "subs-4queues",
                "queue-name": [
                  {
                    "name": "BE_SUBS",
                    "parent-flow": "high-flow",
                    "parent-scheduler-name": "subs-4queues",
                    "connection-point": "strict_priority_3"
                  },
                  {
                    "name": "LD_SUBS",
                    "parent-flow": "high-flow",
                    "parent-scheduler-name": "subs-4queues",
                    "connection-point": "strict_priority_1"
                  },
                  {
                    "name": "LL_SUBS",
                    "parent-flow": "high-flow",
                    "parent-scheduler-name": "subs-4queues",
                    "connection-point": "strict_priority_2"
                  },
                  {
                    "name": "VO_SUBS",
                    "parent-flow": "high-flow",
                    "parent-scheduler-name": "subs-4queues",
                    "connection-point": "strict_priority_0"
                  }
                ]
              }
            ],
            "scheduler-name": [
              {
                "name": "subs-4queues",
                "port-connection": "scheduler_to_port"
              }
            ]
          }
  ]
}
```

To access the RESTCONF API that corresponds to this CLI, click here.

Remark-Map Configuration

Use the following CLI syntax to configure the remark-map:

set forwarding-options class-of-service remark-map <remark-map-name> <attribute> <value>

Command arguments

Attribute	Description
<remark-map-name>	Specifies the remaking map name.
remark-type <remark-type>	Specifies the remarking type - ipv4-tos, ipv6-tc, mpls-ipv4, mpls-ipv6, ieee-802.1, class-to-ip, ip-tos. The "ip-tos" remark-type can be used to set the IPv4 ToS or IPv6 TC values in IPv4 or IPv6 packet header respectively.
remark-type <remark-type> <match-codepoint>	Specifies the match code point for the specified remarking type. On the UfiSpace S9600-72XC and UfiSpace S9600-32X platforms, the match codepoint is TOS for VLAN IEEE-802.1p remarking.
remark-type <remark-type> <match-codepoint> color <color>	Indicates the color - all, green, yellow. Color is used to set different remark codepoints for the same match-codepoint based on color marked by the Policer.
remark-type <remark-type> <match-codepoint> color <color> remark-codepoint <remark-codepoint>	Specifies the remarking codepoint



To manage best-effort upstream traffic when no specific Access Control List is configured in the MFC, it is recommended to apply an ACL that explicitly assigns forwarding-class 0 and remark-map 0. This ensures consistent traffic prioritization for all default flows.

In the following example, the remark map subs-remarking-residential is configured with match-codepoint as 128, 160, 192, and 224. The color is set to "all", and the remark-codepoint is 6.

```
set forwarding-options class-of-service remark-map subs-remarking-residential
set forwarding-options class-of-service remark-map subs-remarking-residential remark-type ieee-802.1
set forwarding-options class-of-service remark-map subs-remarking-residential remark-type ieee-802.1 match-
codepoint 128
set forwarding-options class-of-service remark-map subs-remarking-residential remark-type ieee-802.1 match-
codepoint 128 color all
set forwarding-options class-of-service remark-map subs-remarking-residential remark-type ieee-802.1 match-
codepoint 128 color all remark-codepoint 6
set forwarding-options class-of-service remark-map subs-remarking-residential remark-type ieee-802.1 match-
codepoint 160
set forwarding-options class-of-service remark-map subs-remarking-residential remark-type ieee-802.1 match-
codepoint 160 color all
set forwarding-options class-of-service remark-map subs-remarking-residential remark-type ieee-802.1 match-
codepoint 160 color all remark-codepoint 6
set forwarding-options class-of-service remark-map subs-remarking-residential remark-type ieee-802.1 match-
codepoint 192
set forwarding-options class-of-service remark-map subs-remarking-residential remark-type ieee-802.1 match-
codepoint 192 color all
set forwarding-options class-of-service remark-map subs-remarking-residential remark-type ieee-802.1 match-
codepoint 192 color all remark-codepoint 6
set forwarding-options class-of-service remark-map subs-remarking-residential remark-type ieee-802.1 match-
codepoint 224
set forwarding-options class-of-service remark-map subs-remarking-residential remark-type ieee-802.1 match-
codepoint 224 color all
set forwarding-options class-of-service remark-map subs-remarking-residential remark-type ieee-802.1 match-
codepoint 224 color all remark-codepoint 6
commit
```

The following example shows the remark map configuration:

```
supervisor@rtbrick>LEAF01: cfg> show config forwarding-options class-of-service remark-map remark-exp remark-
type ipv6-tc
{
  "rtbrick-config:remark-type": [
{
            "remark-map-name": "subs-remarking-residential",
            "remark-type": [
              {
                "remark-type": "ieee-802.1",
                "match-codepoint": [
                  {
                    "match-codepoint": 128,
                    "color": [
                      {
                        "color": "all",
                        "remark-codepoint": 6
                      }
                    ]
                  },
                  {
                    "match-codepoint": 160,
                    "color": [
                      {
                        "color": "all",
                        "remark-codepoint": 6
```

```
                    }
                  ]
                },
                {
                  "match-codepoint": 192,
                  "color": [
                    {
                      "color": "all",
                      "remark-codepoint": 6
                    }
                  ]
                },
                {
                  "match-codepoint": 224,
                  "color": [
                    {
                      "color": "all",
                      "remark-codepoint": 6
                    }
                  ]
                }
              ]
            }
          ]
        }
      ]
  }
}
```


API To access the RESTCONF API that corresponds to this CLI, click here.

Global Profile Mapping

Use the following CLI syntax to configure the remark map for a global profile.

set forwarding-options class-of-service global remark-map-name <remark-map-name>

Command arguments

Attribute	Description
<remark-map-name>	Specifies the name of the remark map.

The following example configures the remark map for a global profile:

```
set forwarding-options class-of-service global remark-map-name subs-remarking-residential
```

The following example shows the remark map for a global profile configuration:

```
supervisor@rtbrick>LEAF01: cfg> show config forwarding-options class-of-service global
{
```

```
  "rtbrick-config:global": {
    "multifield-classifier-name": "global_mfc",
    "remark-map-name": "subs-remarking-residential"
  }
}
```

Remark-map to Instance Mapping

Use the following CLI syntax to configure the remark map for an instance.

set forwarding-options class-of-service instance <instance-name> **remark-map-name** <remark-map-name>

Command arguments

Attribute	Description
`<instance-name>	Specifies the name of the instance.`
<remark-map-name>	Specifies the name of the remark map.

The following example configures the remark map for the instance default.

```
set forwarding-options class-of-service instance default remark-map-name subs-remarking-residential
commit
```

The following example shows the remark map configuration for the instance default.

```
supervisor@rtbrick>LEAF01: cfg> show config forwarding-options class-of-service instance default
{
  "rtbrick-config:instance": [
    {
      "name": "default",
      "remark-map-name": "subs-remarking-residential"
    }
  ]
}
```

Configuring QoS L2 and L3 Logical Interfaces

QoS Configuration

To support QoS on L2 logical interface, the class-of-service profile configuration is introduced. If a L2 logical interface is part of an interface-set, logical-interface scheduler/shaper must have parent-scheduler as interface-set-scheduler/shaper.

```
set interface ifp-0/0/16 unit 201
set interface ifp-0/0/16 unit 201 interface-type l2vpn-vpws
set interface ifp-0/0/16 unit 201 instance evpn-vpws-vrf2
set interface ifp-0/0/16 unit 201 vlan 200
set interface ifp-0/0/16 unit 201 inner-vlan 201
set interface ifp-0/0/16 unit 201 class-of-service qos_profile_service_1
set interface ifp-0/0/16 unit 202
set interface ifp-0/0/16 unit 202 interface-type l2vpn-vpws
set interface ifp-0/0/16 unit 202 instance evpn-vpws-vrf2
set interface ifp-0/0/16 unit 202 vlan 200
set interface ifp-0/0/16 unit 202 inner-vlan 202
set interface ifp-0/0/16 unit 202 class-of-service qos_profile_service_2
set interface ifp-0/0/16 unit 203
set interface ifp-0/0/16 unit 203 interface-type l2vpn-vpws
set interface ifp-0/0/16 unit 203 instance evpn-vpws-vrf2
set interface ifp-0/0/16 unit 203 vlan 200
set interface ifp-0/0/16 unit 203 inner-vlan 203
set interface ifp-0/0/16 unit 203 class-of-service qos_profile_service_3
```

Interface-set Configuration

```
set interface-set service-group-1 interface ifp-0/0/16
set interface-set service-group-1 interface ifp-0/0/16 unit 201
set interface-set service-group-1 interface ifp-0/0/16 unit 202
set interface-set service-group-1 interface ifp-0/0/16 unit 203
```

Combining Multiple Logical Interfaces with an Added QoS Hierarchy

Configuring QoS Profile for a Logical Interface or Service

```
set forwarding-options class-of-service profile qos_profile_service_1
set forwarding-options class-of-service profile qos_profile_service_1 classifier-name upstream_pbit_classifer
set forwarding-options class-of-service profile qos_profile_service_1 class-queue-map-name
business_service_class_queue_map
set forwarding-options class-of-service profile qos_profile_service_1 class-policer-map-name
business_service_class_policer_map
set forwarding-options class-of-service profile qos_profile_service_1 policer-name business_service_policer_1
set forwarding-options class-of-service profile qos_profile_service_1 scheduler-map-name
business_service_scheduler_map_1
```

Configuring QoS Profile for a Logical Interface Set

```
set forwarding-options class-of-service profile qos_profile_service_group
set forwarding-options class-of-service profile qos_profile_service_group scheduler-map-name
business_service_group_scheduler_map
```

Enabling QoS Profile for a Logical Interface Set

```
set interface-set service-group-1
set interface-set service-group-1 class-of-service qos_profile_service_group
set forwarding-options class-of-service profile service-group-profile
set forwarding-options class-of-service profile service-group-profile class-queue-map-name subs-4queues
set forwarding-options class-of-service profile service-group-profile class-policer-map-name policer-map-
residential
set forwarding-options class-of-service profile service-group-profile policer-name policer-residential
set forwarding-options class-of-service profile service-group-profile scheduler-map-name
business_service_group_scheduler_map
```

The following CLIs are used to configure scheduler port connection to link schedulers across different scheduler maps:

QoS Scheduler-map to connect logical interface scheduler with interface-set scheduler:

```
set forwarding-options class-of-service scheduler-map schedmap_service_1
set forwarding-options class-of-service scheduler-map schedmap_service_1  scheduler-name sch_service_1
set forwarding-options class-of-service scheduler-map schedmap_service_1  scheduler-name sch_service_1 port-
connection scheduler-map-to-scheduler-map
set forwarding-options class-of-service scheduler-map schedmap_service_1   scheduler-name
business_service_scheduler_1 parent-scheduler-name business_service_group_scheduler
```

QoS Scheduler-map to Connect an interface-set scheduler with a pon scheduler

```
set forwarding-options class-of-service scheduler-map business_service_group_scheduler_map
set forwarding-options class-of-service scheduler-map business_service_group_scheduler_map scheduler-name
business_service_group_scheduler
set forwarding-options class-of-service scheduler-map business_service_group_scheduler scheduler-name
business_service_group_scheduler parent-scheduler-name pon0
set forwarding-options class-of-service scheduler-map business_service_group_scheduler_map scheduler-name
business_service_group_scheduler port-connection scheduler_map_to_scheduler_map
```

QoS Global and Instance Configurations

The figure below shows the dependencies for per instance or global classifier and remark-map configurations.

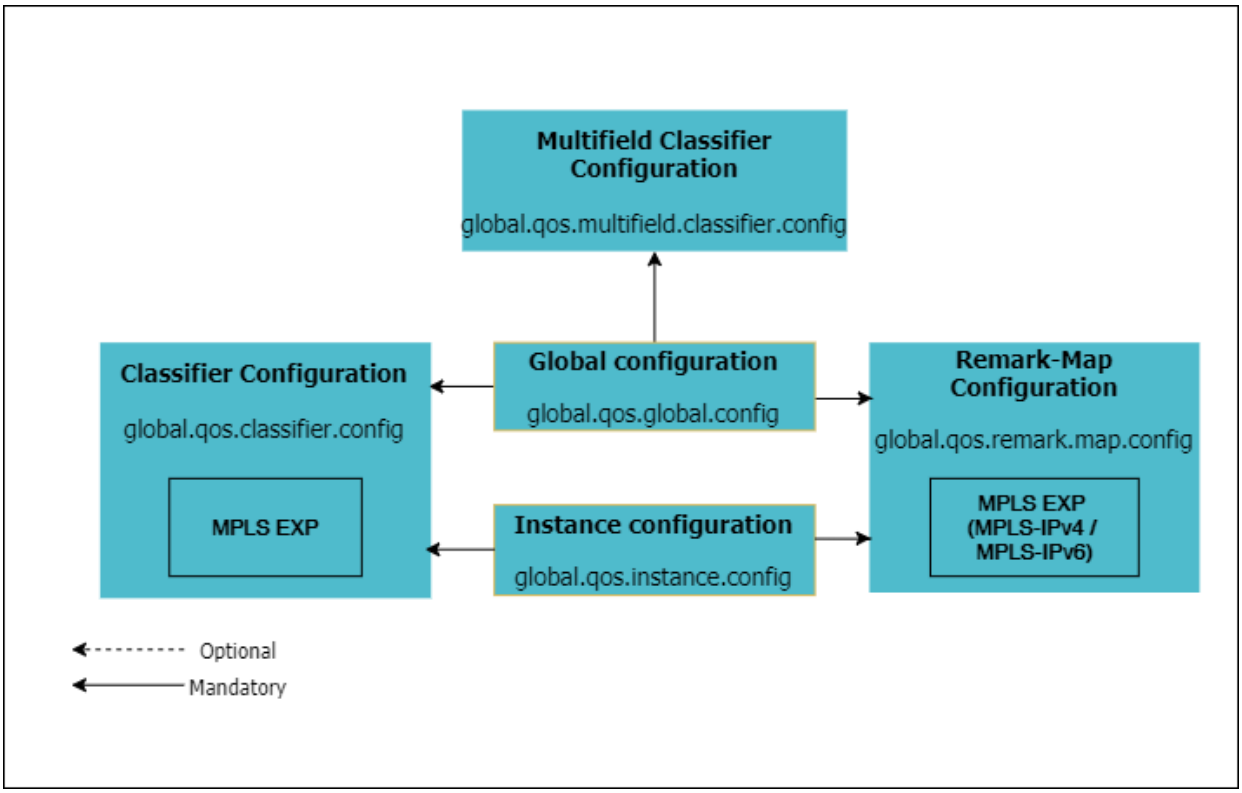


Figure 143. QoS Global and Instance Configurations

The following example configures the BA classifier subs-exp-class for traffic exp with match code point 2 classified as class class-1.

```
set forwarding-options class-of-service classifier subs-exp-class match-type exp codepoint 2 class class-1
```

BA Classifier to Global Mapping

The MPLS classifiers can be applied globally using global configuration.

set forwarding-options class-of-service global classifier-name <classifier-name>

Attribute	Description
<classifier-name>	Specifies the classifier name

The following example shows how to configure the subs-exp-class BA Classifier for global mapping.

```
set forwarding-options class-of-service global classifier-name subs-exp-class
```

The configuration for global mapping to the BA Classifier is shown in the following example.

```
supervisor@rtbrick>LEAF01: cfg> show config  forwarding-options class-of-service global classifier-name
{
  "rtbrick-config:classifier-name": "subs-exp-class"
}
```

Single Queue To Global Mapping

The Single-Queue can be enabled with global configuration.



For the system to initialize with a single queue in a Queue-Group, a system reboot is required.

set forwarding-options class-of-service global queue-group-profile single-queue

The following example shows how to enable single-queue in a Queue-Group.

```
set forwarding-options class-of-service global queue-group-profile single-queue
commit
```

The configuration for a single queue in Queue-Group is shown in the following example.

```
supervisor@rtbrick>LEAF01: cfg> show config forwarding-options class-of-service global
{
  "rtbrick-config:global": {
    "queue-group-profile": "single-queue"
  }
}
```

Remark-Map To Global Mapping

Use the following CLI syntax to configure the remark map for a global profile.

set forwarding-options class-of-service global remark-map-name <remark-map-name>

Command arguments

Attribute	Description
<remark-map-name>	Specifies the name of the remark map.

The following example configures the remark map for a global profile:

```
set forwarding-options class-of-service global remark-map-name subs-remarking-residential
commit
```

Multifield Classifier (MFC) to Global Mapping

Use the following CLI syntax to configure the MF Classifier to Global Mapping:

set forwarding-options class-of-service global multifield-classifier-name <multifield-classifier-name>

Attribute	Description
<multifield-classifier-name>	Specifies the name of the multifield classifier

The following example configures the multifield Classifier to Global Mapping:

```
set forwarding-options class-of-service global multifield-classifier-name global_mfc
commit
```

The following example shows the multifield classifier to Global Mapping configuration:

```
supervisor@rtbrick>LEAF01: cfg> show config forwarding-options class-of-service global
{
  "rtbrick-config:global": {
    "multifield-classifier-name": "global_mfc"
  }
}
```

BA Classifier to Instance Mapping

The MPLS classifiers can be applied at an instance level using instance

configuration.

set forwarding-options class-of-service instance <instance> **classifier-name** <classifier-name>

Attribute	Description
<instance>	Specifies the instance name
<classifier-name>	Specifies the classifier name

The following example shows how to configure the subs-exp-class BA Classifier for the instance default.

```
set forwarding-options class-of-service instance default classifier-name subs-exp-class
commit
```

The configuration for instance mapping to the BA Classifier is shown in the following example.

```
supervisor@rtbrick>LEAF01: cfg> show config forwarding-options class-of-service instance default
{
  "rtbrick-config:instance": [
    {
      "name": "default",
      "classifier-name": "subs-exp-class"
    }
  ]
}
```

Remark-Map To Instance Mapping

Use the following CLI syntax to configure the remark map for an instance.

set forwarding-options class-of-service instance <instance-name> remark-map-name <remark-map-name>

Command arguments

Attribute	Description
<instance-name>	Specifies the name of the instance.

Attribute	Description
<remark-map-name>	Specifies the name of the remark map.

The following example configures the remark map for the instance default:

```
set forwarding-options class-of-service instance default remark-map-name subs-remarking-residential
commit
```

The configuration for the remark map for an instance is shown in the following example.

```
supervisor@rtbrick>LEAF01: cfg> show config forwarding-options class-of-service instance default
{
  "rtbrick-config:instance": [
    {
      "name": "default",
      "remark-map-name": "subs-remarking-residential"
    }
  ]
}
```

Configuring Control Plane QoS Per IFL

Control plane packet marking is supported on a per-IFL basis for the following protocols: BGP, OSPF, LDP, IS-IS, DHCP relay, RADIUS, L2TP, ARP/ND, and PIM. Additionally, IGMP control plane packets can now be marked on a per-IFP basis.

Syntax:

set forwarding-options class-of-service control-plane-qos outbound-marking protocol <protocol-name> **tos codepoint** <value>

set forwarding-options class-of-service control-plane-qos outbound-marking protocol <protocol-name> **tos interface** <interface-name> **codepoint** <value>

Attribute	Description
<protocol-name>	Specifies the name of the protocol.
<interface-name>	Specifies the name of the IFL.

Attribute	Description
codepoint <value>	Specify the codepoint value.

Example configuration for configuring control plane QoS per IFL:

```
set forwarding-options class-of-service control-plane-qos outbound-marking
protocol bgp tos codepoint 20
set forwarding-options class-of-service control-plane-qos outbound-marking
protocol bgp tos ifl ifl-0/0/0/1001
set forwarding-options class-of-service control-plane-qos outbound-marking
protocol bgp tos ifl ifl-0/0/0/3003 codepoint 19
set forwarding-options class-of-service control-plane-qos outbound-marking
protocol bgp tos ifl ifl-0/0/0/3003
set forwarding-options class-of-service control-plane-qos outbound-marking
protocol bgp tos ifl ifl-0/0/0/3003 codepoint 19
```

```
{
    "protocol": "bgp",
    "remark-type": "tos",
    "codepoint": 20,
    "ifl": [
        {
            "ifl": "ifl-0/0/0/1001",
            "codepoint": 19
        },
        {
            "ifl": "ifl-0/0/0/3003",
            "codepoint": 19
        }
    ]
}
```

Control Plane QoS p-bit Support for OAM

RBFS supports control plane QoS p-bit remarking for OAM packets at both the protocol level and the L2-all level.

Syntax:

set forwarding-options class-of-service control-plane-qos outbound-marking protocol cfm p-bit codepoint <value>

Attribute	Description
codepoint <value>	Specify the codepoint value.

Example Command:

```
set forwarding-options class-of-service control-plane-qos outbound-marking
protocol cfm p-bit codepoint 4
```

Example:

```
"rtbrick-config:forwarding-options": {
      "class-of-service": {
        "control-plane-qos": {
          "outbound-marking": {
            "protocol": [
              {
                "protocol": "cfm",
                "remark-type": "p-bit",
                "codepoint": 4
              }
            ]
          }
        }
      }
    },
```

Control Plane Marking (ToS) for MPLS Ping and Traceroute

This feature allows you to set the ToS value in the header of MPLS OAM ping and traceroute packets generated or received by the control plane. It enables the prioritization of MPLS OAM traffic, thereby giving higher priority to diagnostic traffic.

Syntax:

set forwarding-options class-of-service control-plane-qos outbound-marking protocol mpls-oam tos codepoint <value>

Attribute	Description
codepoint <value>	Specify the codepoint value.

Example Command:

```
set forwarding-options class-of-service control-plane-qos outbound-marking
protocol mpls-oam tos codepoint 180
```

Example:

```
supervisor@rtbrick.net: cfg> show config forwarding-options class-of-service
control-plane-qos outbound-marking protocol mpls-oam
{
  "rtbrick-config:protocol": [
    {
      "protocol": "mpls-oam",
      "remark-type": "tos",
      "codepoint": 180
    }
  ]
}
```

Configuring QoS for L2TP LCP Control Plane Packets

RBFS supports for prioritizing L2TP LCP control packets using Layer 3 IPv4 (L3v4) ACLs. It enables the identification of LCP control plane packets and allows for Quality of Service (QoS) marking.

Syntax:

set forwarding-options acl l3v4 rule l2tp_match_lcp ordinal <number> <attribute> <value>

Attribute	Description
ordinal <ordinal-value>	Specifies the ordinal that is used for traffic rule referencing.
match <direction>	Specifies the direction of L3V4 traffic.
match l2tp-ppp-lcp true	Specify 'true' to enable the rule to match the L2TP LCP traffic.
action forward-class <class>	class-0, class-1, class-2, class-3, class-4, class-5, class-6, class-7
action remark-codepoint <remark-codepoint>	Specifies the remark-map codepoint value.
action statistics true	Specify 'true' to generate statistics for the ACL.
priority <value>	Specify the priority value.

The following configuration defines a Layer 3 IPv4 ACL rule to match incoming L2TP PPP LCP packets with specific actions for QoS marking. The name of the L3 IPv4 ACL rule is specified as "l2tp_match_lcp."

The ordinal value, set to 1, indicates the order of execution when there are multiple match-action entries. The match direction is defined as "ingress", indicating that this rule applies to incoming traffic. The match for "l2tp-ppp-lcp" is set to 'true'. It indicates it is applicable to only L2TP PPP LCP control packets.

The action "forward-class" assigns the packet to forwarding class 3 for higher priority. The action "remark-codepoint" is set to the value '100' that help to classify the packets for special QoS treatment. Also, the "action statistics" is enabled by setting it to 'true'. It enables the generation of statistics for this rule. The priority is set to '100', assigning priority level 100 to this rule.

```
set forwarding-options acl l3v4 rule l2tp_match_lcp
set forwarding-options acl l3v4 rule l2tp_match_lcp ordinal 1
set forwarding-options acl l3v4 rule l2tp_match_lcp ordinal 1 match direction
ingress
set forwarding-options acl l3v4 rule l2tp_match_lcp ordinal 1 match l2tp-ppp-lcp
true
set forwarding-options acl l3v4 rule l2tp_match_lcp ordinal 1 action forward-class
class-3
set forwarding-options acl l3v4 rule l2tp_match_lcp ordinal 1 action remark-
codepoint 100
set forwarding-options acl l3v4 rule l2tp_match_lcp ordinal 1 action statistics
true
set forwarding-options acl l3v4 rule l2tp_match_lcp ordinal 1 priority 100
```

```
{
  "rtbrick-config:acl": {
    "l3v4": {
      "rule": [
        {
          "rule-name": "l2tp_match_lcp",
          "ordinal": [
            {
              "ordinal-value": 1,
              "match": {
                "direction": "ingress",
                "l2tp-ppp-lcp": "true"
              },
              "action": {
                "forward-class": "class-3",
                "remark-codepoint": 100,
                "statistics": "true"
              },
              "priority": 100
            }
          ]
        }
```

```
      ]
    }
  }
}
```

DSCP Remarking with ECN Transparency

This feature allows remarking of DSCP (Differentiated Services Code Point) values in IP packets while preserving the ECN (Explicit Congestion Notification) bits. With this feature, RBFS can modify only the DSCP portion of the IP header while keeping the ECN field unchanged.



- To ensure ECN transparency, you must configure the MFC with the remark-dscp-codepoint option. Also, the traffic must match and hit the MFC ACL.
- You cannot configure the remark-dscp-codepoint action when match condition is either ipv4-dscp or ipv4-tos or ipv6-tc.
- Remark code-point (remark-codepoint) and Remark DSCP code-point (remark-dscp-codepoint) are mutually exclusive configurations and cannot be used together.

The following configuration example defines a traffic filter condition and what to perform with matched traffic. It defines when a packet's destination IP is within 132.1.1.0/24 range and the destination L4 port is 65057, then send it using forwarding class 'class-1' and rewrite its DSCP marking to 60.

```
set forwarding-options class-of-service multifield-classifier acl l3v4 rule
global_mfc ordinal 101 match source-ipv4-prefix 132.1.1.1/24
set forwarding-options class-of-service multifield-classifier acl l3v4 rule
global_mfc ordinal 101 match source-l4-port
65057
set forwarding-options class-of-service multifield-classifier acl l3v4 rule
global_mfc ordinal 101 action
set forwarding-options class-of-service multifield-classifier acl l3v4 rule
global_mfc ordinal 101 action forward-class class-1
set forwarding-options class-of-service multifield-classifier acl l3v4 rule
global_mfc ordinal 101 action remark-dscp-codepoint 60
```

```
{
  "rtbrick-config:ordinal": [
    {
      "ordinal-value": 1,
      "match": {
        "destination-ipv4-prefix": "132.1.1.1/24",
        "destination-l4-port": 65057
      },
```

```
      "action": {
        "forward-class": "class-1",
        "remark-dscp-codepoint": 60
      }
    }
  ]
}
```

6.7.3. HQoS Show Running-Configuration

To display the running configuration, use the **show config** command.

Syntax

show config

Example

```
supervisor@rtbrick>LEAF01: cfg> show config forwarding-options
    "rtbrick-config:forwarding-options": {
      "mirror": [
        {
          "name": "m1",
          "destination": {
            "interface": "cpu-0/0/200"
          },
          "source": {
            "direction": "ingress",
            "interface": "ifp-0/1/30"
          }
        }
      ],
      "class-of-service": {
        "classifier": [
          {
            "classifier-name": "subs-pbit-class",
            "match-type": [
              {
                "match-type": "ieee-802.1",
                "codepoint": [
                  {
                    "codepoint": 1,
                    "class": "class-0",
                    "remark-codepoint": 7
                  },
                  {
                    "codepoint": 2,
                    "class": "class-1",
                    "remark-codepoint": 7
                  },
                  {
                    "codepoint": 3,
                    "class": "class-2",
                    "remark-codepoint": 7
```

```
                },
                {
                  "codepoint": 4,
                  "class": "class-3",
                  "remark-codepoint": 7
                }
              ]
            }
          ]
        }
      ],
      "class-policer-map": [
        {
          "class-policer-map-name": "policer-map-residential",
          "class": [
            {
              "class": "class-0",
              "policer-level": "level-1"
            },
            {
              "class": "class-1",
              "policer-level": "level-2"
            },
            {
              "class": "class-2",
              "policer-level": "level-3"
            },
            {
              "class": "class-3",
              "policer-level": "level-4"
            }
          ]
        }
      ],
      "class-queue-map": [
        {
          "class-queue-map-name": "subs-4queues",
          "class": [
            {
              "class-type": "class-0",
              "queue-name": "BE_SUBS"
            },
            {
              "class-type": "class-1",
              "queue-name": "LD_SUBS"
            },
            {
              "class-type": "class-2",
              "queue-name": "LL_SUBS"
            },
            {
              "class-type": "class-3",
              "queue-name": "VO_SUBS"
            }
          ]
        }
      ],
      "global": {
        "multifield-classifier-name": "global_mfc"
      },
      "policer": [
```

```
        {
          "policer-name": "policer-residential",
          "level1-rates": {
            "cir": 2000,
            "cbs": 1000,
            "pir": 2500,
            "pbs": 1000
          },
          "level2-rates": {
            "cir": 3000,
            "cbs": 1000,
            "pir": 3500,
            "pbs": 1000
          },
          "level3-rates": {
            "cir": 4000,
            "cbs": 1000,
            "pir": 4500,
            "pbs": 1000
          },
          "level4-rates": {
            "cir": 1000,
            "cbs": 1000,
            "pir": 1500,
            "pbs": 1000
          },
          "levels": 4,
          "type": "two-rate-three-color"
        }
      ],
      "profile": [
        {
          "profile-name": "residential",
          "classifier-name": "subs-pbit-class",
          "class-queue-map-name": "subs-4queues",
          "remark-map-name": "subs-remarking-residential",
          "class-policer-map-name": "policer-map-residential",
          "policer-name": "policer-residential",
          "scheduler-map-name": "subs-4queues-residential"
        }
      ],
      "queue": [
        {
          "queue-name": "BE_SUBS",
          "queue-size": 375000
        },
        {
          "queue-name": "LD_SUBS",
          "queue-size": 625000
        },
        {
          "queue-name": "LL_SUBS",
          "queue-size": 625000
        },
        {
          "queue-name": "VO_SUBS",
          "queue-size": 156250,
          "shaper-name": "shaper_VO"
        }
      ],
      "queue-group": [
```

```
          {
            "queue-group-name": "subs-4queues",
            "queue-numbers": 4
          }
        ],
        "remark-map": [
          {
            "remark-map-name": "subs-remarking-residential",
            "remark-type": [
              {
                "remark-type": "ieee-802.1",
                "match-codepoint": [
                  {
                    "match-codepoint": 128,
                    "color": [
                      {
                        "color": "all",
                        "remark-codepoint": 6
                      }
                    ]
                  },
                  {
                    "match-codepoint": 160,
                    "color": [
                      {
                        "color": "all",
                        "remark-codepoint": 6
                      }
                    ]
                  },
                  {
                    "match-codepoint": 192,
                    "color": [
                      {
                        "color": "all",
                        "remark-codepoint": 6
                      }
                    ]
                  },
                  {
                    "match-codepoint": 224,
                    "color": [
                      {
                        "color": "all",
                        "remark-codepoint": 6
                      }
                    ]
                  }
                ]
              }
            ]
          }
        ],
        "scheduler": [
          {
            "scheduler-name": "pon0",
            "shaper-name": "gpon-shaper",
            "type": "fair_queueing"
          },
          {
            "scheduler-name": "subs-4queues",
```

```
        "shaper-name": "shaper_session",
        "type": "strict_priority",
        "composite": "false"
      }
    ],
    "scheduler-map": [
      {
        "scheduler-map-name": "schedmap-olt",
        "scheduler-name": [
          {
            "name": "pon0",
            "port-connection": "scheduler_to_port"
          }
        ]
      },
      {
        "scheduler-map-name": "subs-4queues-residential",
        "queue-group-name": [
          {
            "group-name": "subs-4queues",
            "queue-name": [
              {
                "name": "BE_SUBS",
                "parent-flow": "high-flow",
                "parent-scheduler-name": "subs-4queues",
                "connection-point": "strict_priority_3"
              },
              {
                "name": "LD_SUBS",
                "parent-flow": "high-flow",
                "parent-scheduler-name": "subs-4queues",
                "connection-point": "strict_priority_1"
              },
              {
                "name": "LL_SUBS",
                "parent-flow": "high-flow",
                "parent-scheduler-name": "subs-4queues",
                "connection-point": "strict_priority_2"
              },
              {
                "name": "VO_SUBS",
                "parent-flow": "high-flow",
                "parent-scheduler-name": "subs-4queues",
                "connection-point": "strict_priority_0"
              }
            ]
          }
        ],
        "scheduler-name": [
          {
            "name": "subs-4queues",
            "port-connection": "scheduler_to_port"
          }
        ]
      }
    ],
    "shaper": [
      {
        "shaper-name": "shaper_VO",
        "shaping-rate-high": 2000,
        "shaping-rate-low": 0
```

```
          },
          {
            "shaper-name": "shaper_session",
            "shaping-rate-high": 10000,
            "shaping-rate-low": 100
          },
          {
            "shaper-name": "gpon-shaper",
            "shaping-rate-high": 2488000,
            "shaping-rate-low": 32000
          }
        ],
        "multifield-classifier": {
          "acl": {
            "l3v4": {
              "rule": [
                {
                  "rule-name": "global_mfc",
                  "ordinal": [
                    {
                      "ordinal-value": 1001,
                      "match": {
                        "ipv4-tos": 128,
                        "source-ipv4-prefix": "192.0.2.2/32"
                      },
                      "action": {
                        "forward-class": "class-0"
                      }
                    },
                    {
                      "ordinal-value": 1002,
                      "match": {
                        "ipv4-tos": 160,
                        "source-ipv4-prefix": "192.0.2.2/32"
                      },
                      "action": {
                        "forward-class": "class-1"
                      }
                    },
                    {
                      "ordinal-value": 1003,
                      "match": {
                        "ipv4-tos": 192,
                        "source-ipv4-prefix": "192.0.2.2/32"
                      },
                      "action": {
                        "forward-class": "class-2"
                      }
                    },
                    {
                      "ordinal-value": 1004,
                      "match": {
                        "ipv4-tos": 224,
                        "source-ipv4-prefix": "192.0.2.2/32"
                      },
                      "action": {
                        "forward-class": "class-3"
                      }
                    }
                  ]
                }
```

```
            ]
          }
        }
      }
    }
  }
```

6.7.4. HQoS Operational Commands

HQoS Show Commands

The HQoS show commands provide detailed information about the HQoS operation.

show qos classifier

Syntax:

show qos classifier <option>

Option	Description
all	Displays a summary of all the configured classifiers.
interface <interface_name>	Displays only the classifiers applied to a specific interface.
type <key_type>	Key type indicates the interface category, for example, whether its subscriber interface, an L3 IFL, a physical interface and so on.

The following example displays a summary of all the HQoS classifiers.

```
supervisor@rtbrick.net: cfg> show qos classifier all
Interface: ppp-0/0/0/72339069014638603, Classifier: subs-pbit-class, Type: Subscriber
  Match Type           Codepoint  Class     Remark Codepoint Color
  ieee-802.1                   1  class-0                 - -
  ieee-802.1                   2  class-1                 - -
  ieee-802.1                   3  class-2                 - -
  ieee-802.1                   4  class-3                 - -
Interface: ppp-0/0/0/72339069014638599, Classifier: subs-pbit-class, Type: Subscriber
  Match Type           Codepoint  Class     Remark Codepoint Color
  ieee-802.1                   1  class-0                 - -
  ieee-802.1                   2  class-1                 - -
  ieee-802.1                   3  class-2                 - -
  ieee-802.1                   4  class-3                 - -
Interface: ppp-0/0/0/72339069014638601, Classifier: subs-pbit-class, Type: Subscriber
```

```
  Match Type           Codepoint  Class     Remark Codepoint Color
  ieee-802.1                   1  class-0                 - -
  ieee-802.1                   2  class-1                 - -
  ieee-802.1                   3  class-2                 - -
  ieee-802.1                   4  class-3                 - -
Interface: ppp-0/0/0/72339069014638602, Classifier: subs-pbit-class, Type: Subscriber
  Match Type           Codepoint  Class     Remark Codepoint Color
  ieee-802.1                   1  class-0                 - -
  ieee-802.1                   2  class-1                 - -
  ieee-802.1                   3  class-2                 - -
  ieee-802.1                   4  class-3                 - -
Interface: ppp-0/0/0/72339069014638600, Classifier: subs-pbit-class, Type: Subscriber
  Match Type           Codepoint  Class     Remark Codepoint Color
  ieee-802.1                   1  class-0                 - -
  ieee-802.1                   2  class-1                 - -
  ieee-802.1                   3  class-2                 - -
  ieee-802.1                   4  class-3                 - -
Classifier: subs-exp-class, Type: Global
  Match Type           Codepoint  Class     Remark Codepoint Color
  exp                          1  class-0                 - -
  exp                          2  class-1                 - -
  exp                          3  class-2                 - -
  exp                          4  class-3                 - -
```

The following example displays information for the specified classifier.

```
supervisor@rtbrick.net: cfg> show qos classifier all interface ppp-0/0/0/72339069014638603
Interface: ppp-0/0/0/72339069014638603, Classifier: subs-pbit-class, Type: Subscriber
  Match Type           Codepoint  Class     Remark Codepoint Color
  ieee-802.1                   1  class-0                 - -
  ieee-802.1                   2  class-1                 - -
  ieee-802.1                   3  class-2                 - -
  ieee-802.1                   4  class-3                 - -
```

The following example displays information for the specified key type.

```
supervisor@rtbrick.net: cfg> show qos classifier all type Global
Classifier: subs-exp-class, Type: Global
  Match Type           Codepoint  Class     Remark Codepoint Color
  exp                          1  class-0                 - -
  exp                          2  class-1                 - -
  exp                          3  class-2                 - -
  exp                          4  class-3                 - -
```

show qos interface

Syntax:

show qos interface <option>

Option	Description
-	Without any option, this command displays a summary of all the interfaces.
<interface-name>	Displays QoS classifier information for the specified interface.

The following example displays information for the specified interface.

```
supervisor@rtbrick>LEAF01: op> show qos interface ifl-0/0/10/200
Interface           Profile
ifl-0/0/10/200      pta_8queues_comp_on_S
supervisor@rtbrick>LEAF01: op>
```

show qos policer

Syntax:

show qos policer <option>

Option	Description
all	Displays a summary of all the QoS policers.
<policer-name>	Displays QoS policer information.
counter	Displays policer counter information.
<interface-name>	Displays policers applied to a specific interface.
type <key_type>	Key type indicates the interface category, for example, whether its subscriber interface, an L3 IFL, a physical interface and so on.
class-to-policer-map	Displays class-to-policer-map information.

The following example displays a summary of all the QoS policers.

```
supervisor@rtbrick.net: cfg> show qos policer all
Key Name: _DEFAULT_POLICER_10_MB, Key Type: Acl, Policer: _DEFAULT_POLICER_10_MB
Type: two-rate-three-color, Levels: 1, Flags: -
  Level    CIR(Kbps)      PIR(Kbps)      CBS(Kbits)     PBS(Kbits)     Max CIR(Kbps)  Max PIR(Kbps)
  1        10000          10000          33000          33000          -              -
  2        -              -              -              -              -              -
  3        -              -              -              -              -              -
  4        -              -              -              -              -              -
Key Name: _DEFAULT_POLICER_1_MB, Key Type: Acl, Policer: _DEFAULT_POLICER_1_MB
```

```
Type: two-rate-three-color, Levels: 1, Flags: -
  Level    CIR(Kbps)      PIR(Kbps)      CBS(Kbits)     PBS(Kbits)     Max CIR(Kbps)  Max PIR(Kbps)
  1        1000           1000           33000          33000          -              -
  2        -              -              -              -              -              -
  3        -              -              -              -              -              -
  4        -              -              -              -              -              -
Key Name: _DEFAULT_POLICER_100_MB, Key Type: Acl, Policer: _DEFAULT_POLICER_100_MB
Type: two-rate-three-color, Levels: 1, Flags: -
  Level    CIR(Kbps)      PIR(Kbps)      CBS(Kbits)     PBS(Kbits)     Max CIR(Kbps)  Max PIR(Kbps)
  1        100000         100000         33000          33000          -              -
  2        -              -              -              -              -              -
  3        -              -              -              -              -              -
  4        -              -              -              -              -              -
Key Name: _DEFAULT_POLICER_TRAP_20_MB, Key Type: Trap, Policer: _DEFAULT_POLICER_TRAP_20_MB
Type: two-rate-three-color, Levels: 1, Flags: -
  Level    CIR(Kbps)      PIR(Kbps)      CBS(Kbits)     PBS(Kbits)     Max CIR(Kbps)  Max PIR(Kbps)
  1        20000          20000          33000          33000          -              -
  2        -              -              -              -              -              -
  3        -              -              -              -              -              -
  4        -              -              -              -              -              -
Key Name: _DEFAULT_POLICER_20_MB, Key Type: Acl, Policer: _DEFAULT_POLICER_20_MB
Type: two-rate-three-color, Levels: 1, Flags: -
  Level    CIR(Kbps)      PIR(Kbps)      CBS(Kbits)     PBS(Kbits)     Max CIR(Kbps)  Max PIR(Kbps)
  1        20000          20000          33000          33000          -              -
  2        -              -              -              -              -              -
  3        -              -              -              -              -              -
  4        -              -              -              -              -              -
Key Name: ppp-0/0/0/72339069014638600, Key Type: Subscriber-Ifl, Policer: policer-residential-8q
Type: two-rate-three-color, Levels: 4, Flags: -
  Level    CIR(Kbps)      PIR(Kbps)      CBS(Kbits)     PBS(Kbits)     Max CIR(Kbps)  Max PIR(Kbps)
  1        5000           5500           1000           1000           -              -
  2        10000          10500          1000           1000           -              -
  3        5000           5500           1000           1000           -              -
  4        10000          10500          1000           1000           -              -
Key Name: ppp-0/0/0/72339069014638602, Key Type: Subscriber-Ifl, Policer: policer-residential-8q
Type: two-rate-three-color, Levels: 4, Flags: -
  Level    CIR(Kbps)      PIR(Kbps)      CBS(Kbits)     PBS(Kbits)     Max CIR(Kbps)  Max PIR(Kbps)
  1        5000           5500           1000           1000           -              -
  2        10000          10500          1000           1000           -              -
  3        5000           5500           1000           1000           -              -
  4        10000          10500          1000           1000           -              -
Key Name: _DEFAULT_POLICER_5_MB, Key Type: Acl, Policer: _DEFAULT_POLICER_5_MB
Type: two-rate-three-color, Levels: 1, Flags: -
  Level    CIR(Kbps)      PIR(Kbps)      CBS(Kbits)     PBS(Kbits)     Max CIR(Kbps)  Max PIR(Kbps)
  1        5000           5000           33000          33000          -              -
  2        -              -              -              -              -              -
  3        -              -              -              -              -              -
  4        -              -              -              -              -              -
Key Name: _DEFAULT_POLICER_250_MB, Key Type: Acl, Policer: _DEFAULT_POLICER_250_MB
Type: two-rate-three-color, Levels: 1, Flags: -
  Level    CIR(Kbps)      PIR(Kbps)      CBS(Kbits)     PBS(Kbits)     Max CIR(Kbps)  Max PIR(Kbps)
  1        250000         250000         33000          33000          -              -
  2        -              -              -              -              -              -
  3        -              -              -              -              -              -
  4        -              -              -              -              -              -
Key Name: ppp-0/0/0/72339069014638601, Key Type: Subscriber-Ifl, Policer: policer-residential-8q
Type: two-rate-three-color, Levels: 4, Flags: -
  Level    CIR(Kbps)      PIR(Kbps)      CBS(Kbits)     PBS(Kbits)     Max CIR(Kbps)  Max PIR(Kbps)
  1        5000           5500           1000           1000           -              -
  2        10000          10500          1000           1000           -              -
  3        5000           5500           1000           1000           -              -
  4        10000          10500          1000           1000           -              -
Key Name: ppp-0/0/0/72339069014638603, Key Type: Subscriber-Ifl, Policer: policer-residential-8q
Type: two-rate-three-color, Levels: 4, Flags: -
  Level    CIR(Kbps)      PIR(Kbps)      CBS(Kbits)     PBS(Kbits)     Max CIR(Kbps)  Max PIR(Kbps)
  1        5000           5500           1000           1000           -              -
  2        10000          10500          1000           1000           -              -
  3        5000           5500           1000           1000           -              -
  4        10000          10500          1000           1000           -              -
```

The following example displays a summary of all the QoS policers for a specified interface.

```
supervisor@rtbrick.net: cfg> show qos policer all interface ppp-
0/0/0/72339069014638603
Key Name: ppp-0/0/0/72339069014638603, Key Type: Subscriber-Ifl, Policer: policer-
residential-8q
Type: two-rate-three-color, Levels: 4, Flags: -
  Level    CIR(Kbps)      PIR(Kbps)      CBS(Kbits)     PBS(Kbits)     Max
CIR(Kbps)  Max PIR(Kbps)
  1        5000           5500           1000           1000           -
-
  2        10000          10500          1000           1000           -
-
  3        5000           5500           1000           1000           -
-
  4        10000          10500          1000           1000           -
-
```

The following example displays a summary of all the QoS policers for a specified key type.

```
supervisor@rtbrick.net: cfg> show qos policer all type NAT
Key Name: _DEFAULT_NAT_POLICER_50_MB, Key Type: NAT, Policer:
_DEFAULT_NAT_POLICER_50_MB
Type: two-rate-three-color, Levels: 1, Flags: -
  Level    CIR(Kbps)      PIR(Kbps)      CBS(Kbits)     PBS(Kbits)     Max
CIR(Kbps)  Max PIR(Kbps)
  1        50000          50000          33000          33000          -
-
  2        -              -              -              -              -
-
  3        -              -              -              -              -
-
  4        -              -              -              -              -
-
```

The following example displays counter information for the specified counter.

```
supervisor@rtbrick>LEAF01: op> show qos policer counter lag-1
Interface                       Level  Units      Total            Received         Dropped
lag-1                           1      Packets    15773            15773            0
                                       Bytes      2555226          2555226          0
lag-1                           2      Packets    15778            15778            0
                                       Bytes      2556036          2556036          0
lag-1                           3      Packets    15775            15775            0
                                       Bytes      2555550          2555550          0
lag-1                           4      Packets    23661            23661            0
                                       Bytes      3423166          3423166          0
lag-1-egress                    1      Packets    7889             7889             0
                                       Bytes      1420020          1420020          0
lag-1-egress                    2      Packets    7889             7889             0
                                       Bytes      1420020          1420020          0
lag-1-egress                    3      Packets    7889             7889             0
                                       Bytes      1420020          1420020          0
```

```
lag-1-egress                    4       Packets     49177           49177           0
                                        Bytes       8288974         8288974         0
```

show qos profile

Syntax:

show qos profile <option>

Option	Description
-	Without any option, this command displays a summary of all the QoS profiles.
<profile-name>	Displays QoS profile information.

The following example displays a summary of all the QoS profiles.

```
supervisor@rtbrick>LEAF01: op> show qos profile lac_4queues_4classes
Profile: lac_4queues_4classes
   Classifier: residential-pbit-classifier
   Policer: policer-residential
   Scheduler map: lac_4queues_M
   Class queue map: lac_4queues_M
   Remark map: -
   Class policer map: policer-map-l2tp
   Mulifield classifier: -
supervisor@rtbrick>LEAF01: op>
```

show qos queue

Syntax:

show qos queue <option>

Option	Description
all	Displays all configured QoS queues and their operational state.
<interface_name>	Displays queues assigned to a specific interface.
<interface_name> <queue_name>	Displays details for a specific queue on a specified interface.

Option	Description
class-to-queue-map	Displays queue class-to-queue-map information.
counter	Displays QoS queue counter information.
counter <interface-name>	Displays QoS queue counter information for the specified interface.
type <key_type>	Key type indicates the interface category, for example, whether its subscriber interface, an L3 IFL, a physical interface and so on.

The following example displays a summary of all the queues.

```
supervisor@rtbrick.net: cfg> show qos queue all
Interface: hostif-0/0/0, Type: Physical-Interface
  Queue                     Queue Size      Min Thres      Max Thres      Drop Prob  Shaper
  _DEFAULT_IFP_QUEU          268435456              -              -              -  -
  _DEFAULT_IFP_QUEU          268435456              -              -              -  -
  _DEFAULT_IFP_QUEU          268435456              -              -              -  -
  _DEFAULT_IFP_QUEU          268435456              -              -              -  -
  _DEFAULT_IFP_QUEU          268435456              -              -              -  -
  _DEFAULT_IFP_QUEU          268435456              -              -              -  -
  _DEFAULT_IFP_QUEU          268435456              -              -              -  -
  _DEFAULT_IFP_QUEU          268435456              -              -              -  -
Interface: ppp-0/0/0/72339069014638601, Type: Subscriber
  Queue                     Queue Size      Min Thres      Max Thres      Drop Prob  Shaper
  SUBS_Q0                       375000              -              -              -  -
  SUBS_Q1                       625000              -              -              -  -
  SUBS_Q2                       625000              -              -              -  -
  SUBS_Q3                       156250              -              -              -  shaper_VO
  SUBS_Q4                       375000              -              -              -  -
  SUBS_Q5                       625000              -              -              -  -
  SUBS_Q6                       625000              -              -              -  -
  SUBS_Q7                       156250              -              -              -  shaper_VO
Interface: ppp-0/0/0/72339069014638599, Type: Subscriber
  Queue                     Queue Size      Min Thres      Max Thres      Drop Prob  Shaper
  SUBS_Q0                       375000              -              -              -  -
  SUBS_Q1                       625000              -              -              -  -
  SUBS_Q2                       625000              -              -              -  -
  SUBS_Q3                       156250              -              -              -  shaper_VO
  SUBS_Q4                       375000              -              -              -  -
  SUBS_Q5                       625000              -              -              -  -
  SUBS_Q6                       625000              -              -              -  -
  SUBS_Q7                       156250              -              -              -  shaper_VO
```

The following example displays queue information for the specified interface.

```
supervisor@rtbrick.net: cfg> show qos queue all interface ppp-0/0/0/72339069014638603
Interface: ppp-0/0/0/72339069014638603, Type: Subscriber
  Queue                     Queue Size      Min Thres      Max Thres      Drop Prob  Shaper
  SUBS_Q0                       375000              -              -              -  -
  SUBS_Q1                       625000              -              -              -  -
  SUBS_Q2                       625000              -              -              -  -
  SUBS_Q3                       156250              -              -              -  shaper_VO
  SUBS_Q4                       375000              -              -              -  -
  SUBS_Q5                       625000              -              -              -  -
```

```
  SUBS_Q6                       625000              -              -              -  -
  SUBS_Q7                       156250              -              -              -  shaper_VO
```

The following example displays queue information for a specified key type.

```
supervisor@rtbrick.net: cfg> show qos queue all type Subscriber-Ifl
Interface: ppp-0/0/0/72339069014638601, Type: Subscriber
  Queue                      Queue Size      Min Thres      Max Thres      Drop Prob  Shaper
  SUBS_Q0                       375000              -              -              -  -
  SUBS_Q1                       625000              -              -              -  -
  SUBS_Q2                       625000              -              -              -  -
  SUBS_Q3                       156250              -              -              -  shaper_VO
  SUBS_Q4                       375000              -              -              -  -
  SUBS_Q5                       625000              -              -              -  -
  SUBS_Q6                       625000              -              -              -  -
  SUBS_Q7                       156250              -              -              -  shaper_VO
Interface: ppp-0/0/0/72339069014638599, Type: Subscriber
  Queue                      Queue Size      Min Thres      Max Thres      Drop Prob  Shaper
  SUBS_Q0                       375000              -              -              -  -
  SUBS_Q1                       625000              -              -              -  -
  SUBS_Q2                       625000              -              -              -  -
  SUBS_Q3                       156250              -              -              -  shaper_VO
  SUBS_Q4                       375000              -              -              -  -
  SUBS_Q5                       625000              -              -              -  -
  SUBS_Q6                       625000              -              -              -  -
  SUBS_Q7                       156250              -              -              -  shaper_VO
Interface: ppp-0/0/0/72339069014638600, Type: Subscriber
  Queue                      Queue Size      Min Thres      Max Thres      Drop Prob  Shaper
  SUBS_Q0                       375000              -              -              -  -
  SUBS_Q1                       625000              -              -              -  -
  SUBS_Q2                       625000              -              -              -  -
  SUBS_Q3                       156250              -              -              -  shaper_VO
  SUBS_Q4                       375000              -              -              -  -
  SUBS_Q5                       625000              -              -              -  -
  SUBS_Q6                       625000              -              -              -  -
  SUBS_Q7                       156250              -              -              -  shaper_VO
Interface: ppp-0/0/0/72339069014638603, Type: Subscriber
  Queue                      Queue Size      Min Thres      Max Thres      Drop Prob  Shaper
  SUBS_Q0                       375000              -              -              -  -
  SUBS_Q1                       625000              -              -              -  -
  SUBS_Q2                       625000              -              -              -  -
  SUBS_Q3                       156250              -              -              -  shaper_VO
  SUBS_Q4                       375000              -              -              -  -
  SUBS_Q5                       625000              -              -              -  -
  SUBS_Q6                       625000              -              -              -  -
  SUBS_Q7                       156250              -              -              -  shaper_VO
Interface: ppp-0/0/0/72339069014638602, Type: Subscriber
  Queue                      Queue Size      Min Thres      Max Thres      Drop Prob  Shaper
  SUBS_Q0                       375000              -              -              -  -
  SUBS_Q1                       625000              -              -              -  -
  SUBS_Q2                       625000              -              -              -  -
  SUBS_Q3                       156250              -              -              -  shaper_VO
  SUBS_Q4                       375000              -              -              -  -
  SUBS_Q5                       625000              -              -              -  -
  SUBS_Q6                       625000              -              -              -  -
  SUBS_Q7                       156250              -              -              -  shaper_VO
```

The following example displays queue counter information.

```
supervisor@rtbrick>LEAF01: op> show qos queue counter
Interface                    Queue Group           Queue                Class    Units      Received
Queued             Dropped
```

```
                                                                                                Bytes      0
0                   0
ifl-0/1/32/6                    olt-dpu-mgmt-queues    OLT_MGMT              0        Packets    0
0                   0
                                                                                                Bytes      0
0                   0
ifl-0/1/33/4                    olt-dpu-mgmt-queues    OLT_MGMT              0        Packets    0
0                   0
                                                                                                Bytes      0
0                   0
ifl-0/1/33/6                    olt-dpu-mgmt-queues    OLT_MGMT              0        Packets    0
0                   0
                                                                                                Bytes      0
0                   0
ppp-0/1/30/72339069014638594   pta-4queues            BE_PTA                0        Packets    941111
288270              652841
                                                                                                Bytes      942823712
288837428           653986284
ppp-0/1/30/72339069014638594   pta-4queues            LD_PTA                2        Packets    938859
446474              492385
                                                                                                Bytes      942614436
448259896           494354540
ppp-0/1/30/72339069014638594   pta-4queues            LL_PTA                1        Packets    938851
480506              458345
                                                                                                Bytes      942606404
482428024           460178380
ppp-0/1/30/72339069014638594   pta-4queues            VO_PTA                3        Packets    3667257
673116              2994141
                                                                                                Bytes      953486820
175010160           778476660
l2bsa-0/1/30/281479271677953   l2bsa-4queues          BE_L2BSA              0        Packets    0
0                   0
                                                                                                Bytes      0
0                   0
l2bsa-0/1/30/281479271677953   l2bsa-4queues          LD_L2BSA              2        Packets    0
0                   0
                                                                                                Bytes      0
0                   0
l2bsa-0/1/30/281479271677953   l2bsa-4queues          LL_L2BSA              1        Packets    0
0                   0
                                                                                                Bytes      0
0                   0
```

The following example displays queue counter information for the specified interface.

```
supervisor@rtbrick>LEAF01: op> show qos queue counter ifl-0/1/30/6
Interface                       Queue Group            Queue                 Class    Units      Received
Queued              Dropped
ifl-0/1/30/6                    olt-dpu-mgmt-queues    OLT_MGMT              0        Packets    0
0                   0
                                                                                                Bytes      0
0                   0
```

show qos scheduler

Syntax:

show qos scheduler <option>

Option	Description
all	Displays all scheduler profiles configured.
<scheduler-name>	Displays information for the specified scheduler.
type <key_type>	Displays schedulers for the specified type.

The following example displays a summary of all the schedulers.

```
supervisor@rtbrick.net: cfg> show qos scheduler all
Interface Name                 Type                      Scheduler Name  Scheduler Map Name
Shaper Name     Composite
ppp-0/0/0/72339069014638600    Subscriber-Ifl            subs-8queues    subs-8queues-triple-play
shaper_session  False
ppp-0/0/0/72339069014638599    Subscriber-Ifl            subs-8queues    subs-8queues-triple-play
shaper_session  False
ppp-0/0/0/72339069014638602    Subscriber-Ifl            subs-8queues    subs-8queues-triple-play
shaper_session  False
ppp-0/0/0/72339069014638601    Subscriber-Ifl            subs-8queues    subs-8queues-triple-play
shaper_session  False
ppp-0/0/0/72339069014638603    Subscriber-Ifl            subs-8queues    subs-8queues-triple-play
shaper_session  False
```

The following example displays scheduler information for a specified interface.

```
supervisor@rtbrick.net: cfg> show qos scheduler all interface ppp-0/0/0/72339069014638603
Interface Name                 Type                      Scheduler Name  Scheduler Map Name
Shaper Name     Composite
ppp-0/0/0/72339069014638603    Subscriber-Ifl            subs-8queues    subs-8queues-triple-play
shaper_session  False
```

The following example displays scheduler information for the specified key type.

```
supervisor@rtbrick.net: cfg> show qos scheduler all type Subscriber-Ifl
Interface Name                 Type                      Scheduler Name  Scheduler Map Name
Shaper Name     Composite
ppp-0/0/0/72339069014638600    Subscriber-Ifl            subs-8queues    subs-8queues-triple-play
shaper_session  False
ppp-0/0/0/72339069014638599    Subscriber-Ifl            subs-8queues    subs-8queues-triple-play
shaper_session  False
ppp-0/0/0/72339069014638602    Subscriber-Ifl            subs-8queues    subs-8queues-triple-play
shaper_session  False
ppp-0/0/0/72339069014638601    Subscriber-Ifl            subs-8queues    subs-8queues-triple-play
shaper_session  False
ppp-0/0/0/72339069014638603    Subscriber-Ifl            subs-8queues    subs-8queues-triple-play
shaper_session  False
```

show qos remark map

Syntax:

show qos remark-map <option>

Option	Description
all	Displays all remark maps configured in the system.
<interface_name>	Displays remark maps applied to a specific interface.
type <key_type>	Filters remark map for the specified type.

The following example displays a summary of all the remark maps.

```
supervisor@rtbrick.net: cfg> show qos remark-map all
Interface: ppp-0/0/0/72339069014638602, Remark Map: subs-remarking-triple-play-8q, Type: Subscriber
  Remark Type          Match Codepoint     Remark Codepoint    Color
  ieee-802.1                         0                    3    all
  ieee-802.1                         1                    4    all
  ieee-802.1                         2                    5    all
  ieee-802.1                         3                    6    all
  ieee-802.1                         4                    7    all
  ieee-802.1                         5                    0    all
  ieee-802.1                         6                    1    all
  ieee-802.1                         7                    2    all
Interface: ppp-0/0/0/72339069014638599, Remark Map: subs-remarking-triple-play-8q, Type: Subscriber
  Remark Type          Match Codepoint     Remark Codepoint    Color
  ieee-802.1                         0                    3    all
  ieee-802.1                         1                    4    all
  ieee-802.1                         2                    5    all
  ieee-802.1                         3                    6    all
  ieee-802.1                         4                    7    all
  ieee-802.1                         5                    0    all
  ieee-802.1                         6                    1    all
  ieee-802.1                         7                    2    all
Interface: ppp-0/0/0/72339069014638603, Remark Map: subs-remarking-triple-play-8q, Type: Subscriber
  Remark Type          Match Codepoint     Remark Codepoint    Color
  ieee-802.1                         0                    3    all
  ieee-802.1                         1                    4    all
  ieee-802.1                         2                    5    all
  ieee-802.1                         3                    6    all
  ieee-802.1                         4                    7    all
  ieee-802.1                         5                    0    all
  ieee-802.1                         6                    1    all
  ieee-802.1                         7                    2    all
Interface: ppp-0/0/0/72339069014638600, Remark Map: subs-remarking-triple-play-8q, Type: Subscriber
  Remark Type          Match Codepoint     Remark Codepoint    Color
  ieee-802.1                         0                    3    all
  ieee-802.1                         1                    4    all
  ieee-802.1                         2                    5    all
  ieee-802.1                         3                    6    all
  ieee-802.1                         4                    7    all
  ieee-802.1                         5                    0    all
  ieee-802.1                         6                    1    all
  ieee-802.1                         7                    2    all
Interface: ppp-0/0/0/72339069014638601, Remark Map: subs-remarking-triple-play-8q, Type: Subscriber
  Remark Type          Match Codepoint     Remark Codepoint    Color
  ieee-802.1                         0                    3    all
  ieee-802.1                         1                    4    all
  ieee-802.1                         2                    5    all
  ieee-802.1                         3                    6    all
  ieee-802.1                         4                    7    all
  ieee-802.1                         5                    0    all
  ieee-802.1                         6                    1    all
  ieee-802.1                         7                    2    all
```

The following example displays a summary of all the remark maps for a specified

iinterface.

```
supervisor@rtbrick.net: cfg> show qos remark-map all interface ppp-0/0/0/72339069014638601
Interface: ppp-0/0/0/72339069014638601, Remark Map: subs-remarking-triple-play-8q, Type: Subscriber
  Remark Type          Match Codepoint     Remark Codepoint    Color
  ieee-802.1                         0                    3    all
  ieee-802.1                         1                    4    all
  ieee-802.1                         2                    5    all
  ieee-802.1                         3                    6    all
  ieee-802.1                         4                    7    all
  ieee-802.1                         5                    0    all
  ieee-802.1                         6                    1    all
  ieee-802.1                         7                    2    all
```

The following example displays a summary of all the emark maps for a specified key type.

```
supervisor@rtbrick.net: cfg> show qos remark-map all type Subscriber-Ifl
Interface: ppp-0/0/0/72339069014638602, Remark Map: subs-remarking-triple-play-8q, Type: Subscriber
  Remark Type          Match Codepoint     Remark Codepoint    Color
  ieee-802.1                         0                    3    all
  ieee-802.1                         1                    4    all
  ieee-802.1                         2                    5    all
  ieee-802.1                         3                    6    all
  ieee-802.1                         4                    7    all
  ieee-802.1                         5                    0    all
  ieee-802.1                         6                    1    all
  ieee-802.1                         7                    2    all
Interface: ppp-0/0/0/72339069014638599, Remark Map: subs-remarking-triple-play-8q, Type: Subscriber
  Remark Type          Match Codepoint     Remark Codepoint    Color
  ieee-802.1                         0                    3    all
  ieee-802.1                         1                    4    all
  ieee-802.1                         2                    5    all
  ieee-802.1                         3                    6    all
  ieee-802.1                         4                    7    all
  ieee-802.1                         5                    0    all
  ieee-802.1                         6                    1    all
  ieee-802.1                         7                    2    all
Interface: ppp-0/0/0/72339069014638603, Remark Map: subs-remarking-triple-play-8q, Type: Subscriber
  Remark Type          Match Codepoint     Remark Codepoint    Color
  ieee-802.1                         0                    3    all
  ieee-802.1                         1                    4    all
  ieee-802.1                         2                    5    all
  ieee-802.1                         3                    6    all
  ieee-802.1                         4                    7    all
  ieee-802.1                         5                    0    all
  ieee-802.1                         6                    1    all
  ieee-802.1                         7                    2    all
Interface: ppp-0/0/0/72339069014638600, Remark Map: subs-remarking-triple-play-8q, Type: Subscriber
  Remark Type          Match Codepoint     Remark Codepoint    Color
  ieee-802.1                         0                    3    all
  ieee-802.1                         1                    4    all
  ieee-802.1                         2                    5    all
  ieee-802.1                         3                    6    all
  ieee-802.1                         4                    7    all
  ieee-802.1                         5                    0    all
  ieee-802.1                         6                    1    all
  ieee-802.1                         7                    2    all
```

show qos scheduler-map

Syntax:

show qos scheduler-map <option>

Option	Description
-	Without any option, this command displays a summary of all the scheduler maps.
<scheduler-map>	Displays scheduler information for the specified scheduler map.

The following example displays a summary of all the scheduler maps.

```
supervisor@rtbrick>LEAF01: op> show qos scheduler-map
Scheduler-Map: lac_4queues_S
   Scheduler: fff                   Scheduler: strict_priority
     Queue: LD_S                    strict_priority_1
     Scheduler: pta_4queues_comp_off  Scheduler: strict_priority
       Queue: LL_S                    strict_priority_1
       Queue: VO_S                    strict_priority_0
   Scheduler: fffd                  Scheduler: strict_priority
     Queue: BE_S                    strict_priority_0
Scheduler-Map: schedmap-olt
   Scheduler: olt-pon1              Scheduler: fair_queueing
   Scheduler: olt-pon2              Scheduler: fair_queueing
   Scheduler: olt-pon3              Scheduler: fair_queueing
   Scheduler: olt-pon4              Scheduler: fair_queueing
   Scheduler: olt-pon5              Scheduler: fair_queueing
   Scheduler: olt-pon6              Scheduler: fair_queueing
   Scheduler: olt-pon7              Scheduler: fair_queueing
   Scheduler: olt-pon8              Scheduler: fair_queueing
   Scheduler: olt-pon9              Scheduler: fair_queueing
   Scheduler: olt-pon10             Scheduler: fair_queueing
   Scheduler: olt-pon11             Scheduler: fair_queueing
   Scheduler: olt-pon12             Scheduler: fair_queueing
   Scheduler: olt-pon13             Scheduler: fair_queueing
   Scheduler: olt-pon14             Scheduler: fair_queueing
   Scheduler: olt-pon15             Scheduler: fair_queueing
   Scheduler: olt-pon16             Scheduler: fair_queueing
   Scheduler: olt-pon17             Scheduler: fair_queueing
   Scheduler: olt-pon18             Scheduler: fair_queueing
   Scheduler: olt-pon19             Scheduler: fair_queueing
   Scheduler: olt-pon20             Scheduler: fair_queueing
   Scheduler: olt-pon21             Scheduler: fair_queueing
   Scheduler: olt-pon22             Scheduler: fair_queueing
   Scheduler: olt-pon23             Scheduler: fair_queueing
   Scheduler: olt-pon24             Scheduler: fair_queueing
   Scheduler: olt-pon25             Scheduler: fair_queueing
   Scheduler: olt-pon26             Scheduler: fair_queueing
   Scheduler: olt-pon27             Scheduler: fair_queueing
```

```
   Scheduler: olt-pon28             Scheduler: fair_queueing
   Scheduler: olt-pon29             Scheduler: fair_queueing
   Scheduler: olt-pon30             Scheduler: fair_queueing
   Scheduler: olt-pon31             Scheduler: fair_queueing
   Scheduler: olt-pon32             Scheduler: fair_queueing
   Scheduler: olt-pon33             Scheduler: False
Scheduler-Map: lac_4queues_L
   Scheduler: lac_4queues           Scheduler: strict_priority
     Queue: BE_L                    strict_priority_1
     Queue: LD_L                    strict_priority_1
     Queue: LL_L                    strict_priority_2
     Queue: VO_L                    strict_priority_0
```

The following example displays scheduler information for the specified scheduler-map.

```
supervisor@rtbrick>LEAF01: op> show qos scheduler-map lac_4queues_S
Scheduler-Map: lac_4queues_S
   Scheduler: fff                   Scheduler: strict_priority
     Queue: LD_S                    strict_priority_1
     Scheduler: pta_4queues_comp_off  Scheduler: strict_priority
       Queue: LL_S                    strict_priority_1
       Queue: VO_S                    strict_priority_0
   Scheduler: fffd                  Scheduler: strict_priority
     Queue: BE_S                    strict_priority_0
```

show qos shaper

Syntax:

show qos shaper <option>

Option	Description
-	Without any option, this command displays a summary of all the shapers.
<shaper-name>	Displays scheduler information for the specified shaper.

The following example displays a summary of all the shapers.

```
supervisor@rtbrick>LEAF01: op> show qos shaper
Shaper              High Rate(Kbps)     Low Rate(Kbps)      High Burst(Kb)      Low Burst(Kb)       Active
pon-shaper          2488000             -                   -                   -                   True
shaper_IO           -                   1000000             -                   -                   True
shaper_LD           1000000             -                   -                   -                   True
shaper_LL           1000000             -                   -                   -                   True
shaper_VO           1000000             -                   -                   -                   True
```

```
shaper_session      1000000            100                -                  -                  True
```

The following example displays shaper information for the specified shaper.

```
supervisor@rtbrick>LEAF01: op> show qos shaper shaper_session
Shaper              High Rate(Kbps)     Low Rate(Kbps)      High Burst(Kb)      Low Burst(Kb)       Active
shaper_session      1000000             100                 -                   -                   False
```

show qos multifield-classifier

Syntax:

show qos multifield-classifier <option>

Option	Description
-	Without any option, this command displays a summary of all the multifield classifiers.
<multifield-classifier-name>	Displays scheduler information for the specified multifield classifiers.

The following example displays a summary of all the multifield classifiers.

```
supervisor@rtbrick>LEAF01: op> show qos multifield-classifier
Multifield Classifier: global-mfc
  ACL type: multifield_ipv4
  Ordinal: 10000
    Match:
      Source IPv4 prefix: 198.51.100.2/24
      IPv4 TOS: 224
    Action:
      Forward class: class-7
  Priority: 1000
  Ordinal: 9000
    Match:
      Source IPv4 prefix: 198.51.100.2/24
      IPv4 TOS: 192
    Action:
      Remark codepoint: 184
      Forward class: class-6
  Ordinal: 6200
    Match:
      Source IPv4 prefix: 198.51.100.2/24
      IPv4 TOS: 160
    Action:
      Remark codepoint: 184
      Forward class: class-5
  Ordinal: 5200
```

```
    Match:
      Source IPv4 prefix: 198.51.100.2/24
      IPv4 TOS: 64
    Action:
      Remark codepoint: 184
      Forward class: class-2
  Ordinal: 6000
    Match:
      Source IPv4 prefix: 198.51.100.2/24
      IPv4 TOS: 96
    Action:
      Remark codepoint: 184
      Forward class: class-3
  Ordinal: 5000
    Match:
      Source IPv4 prefix: 198.51.100.2/24
    Action:
      Remark codepoint: 184
      Forward class: class-0
  Ordinal: 6100
    Match:
      Source IPv4 prefix: 198.51.100.2/24
      IPv4 TOS: 128
    Action:
      Remark codepoint: 184
      Forward class: class-4
  Ordinal: 5100
    Match:
      Source IPv4 prefix: 198.51.100.2/24
      IPv4 TOS: 32
    Action:
      Remark codepoint: 184
      Forward class: class-1
  Ordinal: 100
    Match:
      Source IPv6 prefix: 2001:db8:0:100::/32
      IPv6 TC: 224
    Action:
      Remark codepoint: 196
      Forward class: class-3
Multifield Classifier: ipoe-double-play
  ACL type: multifield_ipv4
  Ordinal: 5200
    Match:
      Destination IPv4 prefix: 198.51.100.2/24
      IPv4 TOS: 160
    Action:
      Remark codepoint: 224
      Forward class: class-2
  Ordinal: 5000
    Match:
      Destination IPv4 prefix: 198.51.100.2/24
      IPv4 TOS: 64
    Action:
      Remark codepoint: 224
      Forward class: class-0
  Ordinal: 5300
    Match:
      Destination IPv4 prefix: 198.51.100.2/24
      IPv4 TOS: 192
    Action:
```

```
      Remark codepoint: 224
      Forward class: class-3
  Ordinal: 5100
    Match:
      Destination IPv4 prefix: 198.51.100.2/24
      IPv4 TOS: 96
    Action:
      Remark codepoint: 224
      Forward class: class-1
supervisor@rtbrick>LEAF01: op>
```

The following example displays multifield-classifier information for the specified multifield-classifier.

```
supervisor@rtbrick>LEAF01: op> show qos multifield-classifier global-mfc
Multifield Classifier: global-mfc
  ACL type: multifield_ipv4
  Ordinal: 10000
    Match:
      Source IPv4 prefix: 198.51.100.2/24
      IPv4 TOS: 224
    Action:
      Forward class: class-7
  Priority: 1000
  Ordinal: 9000
    Match:
      Source IPv4 prefix: 198.51.100.2/24
      IPv4 TOS: 192
    Action:
      Remark codepoint: 184
      Forward class: class-6
  Ordinal: 6200
    Match:
      Source IPv4 prefix: 198.51.100.2/24
      IPv4 TOS: 160
    Action:
      Remark codepoint: 184
      Forward class: class-5
  Ordinal: 5200
    Match:
      Source IPv4 prefix: 198.51.100.2/24
      IPv4 TOS: 64
    Action:
      Remark codepoint: 184
      Forward class: class-2
supervisor@rtbrick>LEAF01: op>
```

Displaying QoS Statistics for Layer-2 and Layer-3 Logical Interfaces



Due to hardware limitations in the ASIC, the QoS dropped counters may show inaccurate values during times of congestion. At present, only the forward counters can be considered reliable.

To display QoS Statistics for layer-2 and layer-3 logical interfaces, enter the following command:

show interface <layer-2/layer-3 interface> **statistics**

To obtain detailed view of QoS statistics for layer-2 and layer-3 logical interfaces, enter the following command:

show interface <layer-2/layer-3 interface> **detail**

To clear QoS statistics of layer-2 and layer-3 logical interfaces, enter the following command:

clear interface statistics <layer-2/layer-3 interface>

The following example displays QoS Statistics for the interface ifl-0/1/46/501.

```
supervisor@rtbrick>LEAF01: op> show interface ifl-0/1/46/501 statistics
Logical Interface:  ifl-0/1/46/501
  VPP statistics:
    Counter              Unit      Count
  Packet statistics:
    Ingress forwarded packets: 67598           Ingress forwarded bytes: 69872136
    Ingress drop Packets: 12378422             Ingress drop bytes: 12799221528
    Egress forwarded packets: 67370            Egress forwarded bytes: 69369760
    Egress drop packets: 0                     Egress drop bytes: 0
    Egress Class (Queue) Statistics:
        class-0: 67370 packets 69369760 bytes dropped: 0 packets 0 bytes
        class-1: 0 packets 0 bytes dropped: 0 packets 0 bytes
        class-2: 0 packets 0 bytes dropped: 0 packets 0 bytes
        class-3: 0 packets 0 bytes dropped: 0 packets 0 bytes
        class-4: 0 packets 0 bytes dropped: 0 packets 0 bytes
        class-5: 0 packets 0 bytes dropped: 0 packets 0 bytes
        class-6: 0 packets 0 bytes dropped: 0 packets 0 bytes
        class-7: 0 packets 0 bytes dropped: 0 packets 0 bytes
    Ingress Policer Statistics:
        Level 1: 0 packets 0 bytes dropped: 0 packets 0 bytes
        Level 2: 0 packets 0 bytes dropped: 0 packets 0 bytes
        Level 3: 0 packets 0 bytes dropped: 0 packets 0 bytes
        Level 4: 67598 packets 69872136 bytes dropped: 12378422 packets 12799221528 bytes
supervisor@rtbrick>ufi07.q2c.u21.r4.nbg.rtbrick.net: op>
```

The following example displays detailed QoS Statistics for the interface ifl-0/1/46/501.

```
supervisor@rtbrick>LEAF01: op> show interface ifl-0/1/46/501 detail
Logical Interface:  ifl-0/1/46/501
  VPP statistics:
    Counter              Unit      Count
  Packet statistics:
    Ingress forwarded packets: 67598           Ingress forwarded bytes: 69872136
    Ingress drop Packets: 12378422             Ingress drop bytes: 12799221528
```

```
    Egress forwarded packets: 67370            Egress forwarded bytes: 69369760
    Egress drop packets: 0                     Egress drop bytes: 0
    Egress Class (Queue) Statistics:
        class-0: 67370 packets 69369760 bytes dropped: 0 packets 0 bytes
        class-1: 0 packets 0 bytes dropped: 0 packets 0 bytes
        class-2: 0 packets 0 bytes dropped: 0 packets 0 bytes
        class-3: 0 packets 0 bytes dropped: 0 packets 0 bytes
        class-4: 0 packets 0 bytes dropped: 0 packets 0 bytes
        class-5: 0 packets 0 bytes dropped: 0 packets 0 bytes
        class-6: 0 packets 0 bytes dropped: 0 packets 0 bytes
        class-7: 0 packets 0 bytes dropped: 0 packets 0 bytes
    Ingress Policer Statistics:
        Level 1: 0 packets 0 bytes dropped: 0 packets 0 bytes
        Level 2: 0 packets 0 bytes dropped: 0 packets 0 bytes
        Level 3: 0 packets 0 bytes dropped: 0 packets 0 bytes
        Level 4: 67598 packets 69872136 bytes dropped: 12378422 packets 12799221528 bytes
```

6.8. LLDP

6.8.1. LLDP Overview

Link Layer Discovery Protocol (LLDP) is a media-independent link layer protocol used by network devices for advertising their identity, capabilities to neighbors on a LAN segment. LLDP runs over the data-link layer only, allowing two systems running different network layer protocols to learn about each other.

LLDP supports a set of attributes that it uses to discover neighbor devices. These attributes contain type, length, and value descriptions and are referred to as TLVs. LLDP supported devices can use TLVs to receive and send information to their neighbors. Details such as configuration information, device capabilities, and device identity can be advertised using this protocol.

Guidelines

- All LLDP packets are sent to the CPU for further processing.
- LLDP packets will be lower priority packets when compared with the routing protocol packets. In case of a congestion, the LLDP packets may be policed.

Limitations

- LLDP currently does not intend to work on bundle interfaces.
- LLDP is disabled for the following interfaces on L2BSA L2X:

    Physical interfaces on Q2C platform

    LAG member interfaces on QAX platform

Interactions with other features

RBFS provides various daemons that run as background processes. LLDP interacts with these daemons for accessing necessary configurations.

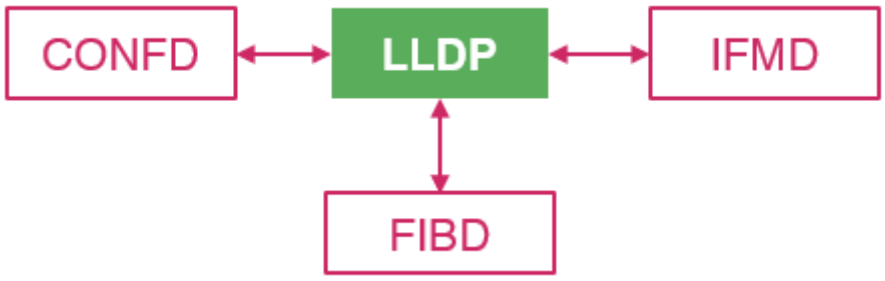


Figure 144. LLDP Interactions

The table below shows the interactions of LLDP with the other daemons of RBFS.

Interactions of LLDP with other daemons

Daemon Name	Daemon Description	Interaction Details
Confd	Configuration	*Confd* stores all the LLDP configuration information. LLDP subscribes for the following tables of *Confd*: • global.lldp.config • global.lldp.interface.config
IFMD	Interface Monitoring	LLDP is enabled on the physical interface. LLDP subscribes to the IFP table to find the status of the physical link. An LLDP message can be sent only to those interfaces whose link state is UP.

Daemon Name	Daemon Description	Interaction Details
FIBD	Forwarding Information Base	*FIBD* subscribes for the LLDP interface table which has all the information required for enabling LLDP on the interface. This is used to program in VPP. Any neighbor detected, VPP will notify and this detection is stored in the FIBD table for tracking purpose. Each time a message is received from the neighbor, it will be updated in this table. Thus, the history of the messages received from the neighbor is tracked. This information is stored in one of the FIBD tables. LLDP subscribes to this table to find its neighbor.

LLDP Limitations with L2X

LLDP is disabled in the following scenario:

1. The outgoing-interface is configured in the egress L2X.
2. The outgoing-interface is configured in the ingress L2X with the match-type as "any" or "untagged".
3. The outgoing-interface and incoming-interface are configured in the bi-directional L2X.

Supported Platforms

Not all features are necessarily supported on each hardware platform. Refer to the *Platform Guide* for the features and the sub-features that are or are not supported by each platform.

6.8.2. LLDP Configuration

Configuration Hierarchy

The diagram illustrates the LLDP configuration hierarchy.

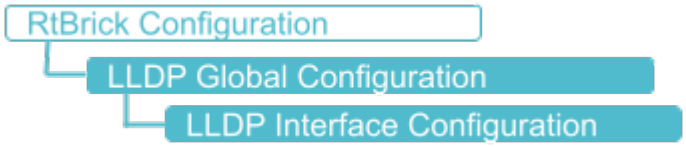


Figure 145. LLDP Configuration Hierarchy

Configuration Syntax and Commands

The following sections describe the LLDP configuration syntax and commands.

LLDP Global Configuration

Syntax:

set lldp <attribute> <value>

Attribute	Description
admin-status [disable|enable]	Enable or disable LLDP. LLDP is enabled, by default.
system-description <system description>	LLDP global system description to be sent to the neighbor
system-name <system name>	LLDP global system name to be sent to the neighbor. If the system name is not configured, it is fetched from BDS.
tx-hold <transmit hold time>	Specifies the amount of time (in seconds) a receiving device maintains the neighbor information before aging your device. If the timer expires and no LLPD packet was received, the neighbor will be marked as DOWN. Default value is 120 seconds. The hold-time range is 1 through 360000.
tx-interval <advertisement interval>	Interval (in seconds) at which LLDP packets are sent to neighbors. Default interval value is 30 seconds. The transmission interval range is 1 through 3600 seconds.

Example 1: Enable LLDP

```
{
    "rtbrick-config:lldp": {
      "admin-status": "enable",
      "system-name": "rtbrick",
      "system-description": "This is rtbrick system",
      "tx-interval": 40,
      "tx-hold": 150
    }
  }
```

To access the RESTCONF API that corresponds to this CLI, click here.

LLDP Interface Configuration

Syntax:

set lldp interface <interface-name> <attribute> <value>

Attribute	Description
interface <interface name>	Name of the interface on which you enable or disable LLDP. By default, the interface is enabled. NOTE: Interface level configuration will override the global LLDP enable/disable functionality.
admin-status [disable or enable]	LLDP is enabled by default. The command *set lldp admin-status disable* is used to disable it. If you want to re-enable it, run the *set lldp admin-status enable* command.
port-desc <port description>	LLDP port description to be sent to the neighbor. If the port description is not configured, the description configured under interface from IFMD is taken as LLDP port description.

Example 1: LLDP on Interface Configuration

```
{
    "rtbrick-config:lldp": {
      "interface": [
        {
          "interface-name": "ifp-0/0/1",
          "port-description": "this is port ifp-0/0/1",
          "admin-status": "enable"
        }
      ]
```

```
    }
  }
```

API To access the RESTCONF API that corresponds to this CLI, click here.

6.8.3. LLDP Operational Commands

LLDP Show Commands

The LLDP show commands provide detailed information about the LLDP global summary, neighbors, and interfaces.

Syntax:

show lldp <option>

Option	Description
interface	Displays information about interfaces where LLDP is enabled.
neighbor	Displays information about all the neighbors.
summary	Displays global summary details such as system name, frequency of transmissions, the hold-time for the packets sent, TLVs, and the disabled TLVs.

LLDP Interfaces

The command displays the information about interfaces where LLDP is enabled.

Syntax:

show lldp interface <attribute> <value>

Option	Description
interface-name	Displays summary details such as status, MAC address and description.

Example 1: LLDP interface summary

```
root@rtbrick: op> show lldp interface
Interface name       Status  MAC address           Description
ifp-0/0/0                    Down    7a:77:6a:01:00:01   Physical interface #0 from
node 0, chip 0
ifp-0/0/1                    Up         7a:77:6a:01:00:02   Physical interface #1
from node 0, chip 0
ifp-0/0/2                    Up          7a:77:6a:01:00:05   Physical interface #2
from node 0, chip 0
```

Example 2: For the interfaces where L2X is configured, LLDP is suppressed as shown in the following example.

```
root@rtbrick: op> show lldp interface
Interface name Status MAC address Description
ifp-0/0/0 Suppress 7a:3a:ce:60:00:00 Suppressed by L2X : L2X1
ifp-0/0/1 Suppress 7a:3a:ce:60:00:01 Suppressed by L2X : L2X2
```

LLDP Neighbors

This command displays the information of all neighbors.

Syntax:

show lldp neighbor <attribute> <value>

Option	Description
detail	Displays the information in detail about a specific LLDP neighbor or all neighbors.
interface-name	Name of the interface on which neighbor is formed.

Example 1: LLDP neighbor summary

```
root@rtbrick: op> show lldp  neighbor
Neighbor name      Status  Remote port ID     Local port ID      Neighbor MAC
address  Last received     Last sent
fwdd-r2                   Up         ifp-0/0/1                 ifp-0/0/1
7a:1a:c9:00:00:01            0:00:05 ago       0:00:05 ago
fwdd-r2                   Up         ifp-0/0/2                 ifp-0/0/2
7a:1a:c9:00:00:04            0:00:05 ago       0:00:05 ago
```

Example 2: LLDP all neighbor details

```
root@rtbrick: op> show lldp neighbor detail

Neighbor: fwdd-r2
  Neighbor MAC address: 7a:1a:c9:00:00:01
  Neighbor port ID: ifp-0/0/1
  Neighbor port description: Physical interface #1 from node 0, chip 0
  Neighbor TTL: 121
  Neighbor timeout: 121000
  Local interface: ifp-0/0/1
  Local MAC address: 7a:77:6a:01:00:02
  Local port description: Physical interface #1 from node 0, chip 0
  Packets sent: 35
  Packets received: 36
  Neighbor status: Up

Neighbor: fwdd-r2
  Neighbor MAC address: 7a:1a:c9:00:00:04
  Neighbor port ID: ifp-0/0/2
  Neighbor port description: Physical interface #2 from node 0, chip 0
  Neighbor TTL: 121
  Neighbor timeout: 121000
  Local interface: ifp-0/0/2
  Local MAC address: 7a:77:6a:01:00:05
  Local port description: Physical interface #2 from node 0, chip 0
  Packets sent: 35
  Packets received: 36
  Neighbor status: Up
```

Example 3: LLDP specific neighbor details

```
root@rtbrick: op> show lldp neighbor ifp-0/0/1
Neighbor: fwdd-r2
  Neighbor MAC address: 7a:1a:c9:00:00:01
  Neighbor port ID: ifp-0/0/1
  Neighbor port description: Physical interface #1 from node 0, chip 0
  Neighbor TTL: 121
  Neighbor timeout: 121000
  Local interface: ifp-0/0/1
  Local MAC address: 7a:77:6a:01:00:02
  Local port description: Physical interface #1 from node 0, chip 0
  Packets sent: 148
  Packets received: 149
  Neighbor status: Up
```

API To access the Operational State API that corresponds to this CLI, click include::common:partial$operational_api_links.adoc[tag=show_lldp_neighbor].

LLDP Summary

The command displays the LLDP global summary information.

Syntax:

show lldp summary

Option	Description
-	Without any options, the command displays LLDP global summary details such as status, MAC address and description.

Example 1: LLDP System Summary

```
root@rtbrick: op> show lldp summary
Mode: global
  System hostname: fwdd-r1
  Transmit interval: 30 sec
  Transmit holdtime: 120 sec
```

LLDP Clear Commands

Clear commands allow to reset operational states.

LLDP Neighbor

This commands resets LLDP neighbor.

Syntax:

clear lldp neighbor <option>

Option	Description
all	Clears all the LLDP neighbors.
<ifp-0/0/1>	Clears a specific neighbor on an interface.

Example: The example below shows how to clear all the LLDP neighbors.

```
supervisor@rtbrick: op> clear lldp neighbor all
```

7. OAM

7.1. CFM

7.1.1. Ethernet Connectivity Fault Management

Overview

RBFS supports Connectivity Fault Management (CFM) that functions as an Ethernet layer Operations, Administration, and Maintenance (OAM) protocol. This feature enables connectivity monitoring, fault verification, and isolation, thereby ensuring network reliability.

CFM is used to detect, verify, and isolate connectivity issues within Ethernet networks. It operates over Ethernet, and utilizes Ethernet frames for communication.



RBFS OAM supports both point-to-point and point-to-multipoint CFM sessions.

Nexthop Tracking

RBFS supports nexthop tracking for Layer 2 issues using CFM (Connectivity Fault Management) sessions. It tracks the reachability of nexthop devices on a network path when CFM is enabled. The functionality enables detection of routing failures by continuously monitoring the availability and responsiveness of nexthop nodes.



CFM next-hop tracking is not supported for MPLS, VPN, IPv4 and IPv6 labeled unicast address families.

Supported Platforms

Not all features are necessarily supported on each hardware platform. Refer to the *Platform Guide* for the features and the sub-features that are or are not supported by each platform.

7.1.2. CFM Configuration

Configuring Connectivity Fault Management

To enable the connectivity fault management feature, you need to configure a CFM session.

Creating a CFM Session

OAM CFM supports both point-to-point and point-to-multipoint sessions.

Syntax:

set oam cfm session <session-name> <attribute> <value>

Attribute	Description
continuity-check-interval	Specify continuity check interval time (in seconds). Supported intervals are: 1s, 10s and 100ms. Default value is 1 second.
interface	Logical interface name.
level	Specify the CFM level. Allowed range: 0 - 7.
local-mep	Specify the local end-point identifier. Range: 1-8191.
maintenance-association	Maintenance association name.
maintenance-domain	Maintenance domain name.
remote-mep	Remote end-point identifier. Range: 1-8191.

 To access the RESTCONF API that corresponds to this CLI, click here.

Example: Point-to-point CFM session configuration

This following configuration defines two CFM sessions on two different interfaces. The sessions, named CFM_DEFAULT_LINK1 and CFM_DEFAULT_LINK2, use the same maintenance domains and different maintenance associations where the domain level is set to 2. The continuity-check interval is configured at 1 second. The continuity check messages (CCMs) are sent every second to verify the link connectivity.

The local MEP is specified as '1000' for CFM_DEFAULT_LINK1 and '1001' for CFM_DEFAULT_LINK2. The remote MEP values are set to '2000' for

CFM_DEFAULT_LINK1 and '2001' for CFM_DEFAULT_LINK2 that indicates the remote endpoint for the link validation.

The local MEPs sends CCM messages every second to the remote MEPs. If no CCMs are received from the remote MEPs until CCM threshold (3.5 * CCM interval), it indicates a link fault and CFM session state is marked down.

```
set oam cfm session CFM_DEFAULT_LINK1
set oam cfm session CFM_DEFAULT_LINK1 level 2
set oam cfm session CFM_DEFAULT_LINK1 maintenance-domain MD_BNG
set oam cfm session CFM_DEFAULT_LINK1 maintenance-association MA_DEFAULT_100
set oam cfm session CFM_DEFAULT_LINK1 continuity-check-interval 1s
set oam cfm session CFM_DEFAULT_LINK1 local-mep 1000
set oam cfm session CFM_DEFAULT_LINK1 remote-mep 2000
set oam cfm session CFM_DEFAULT_LINK1 interface ifl-0/0/0/100
set oam cfm session CFM_DEFAULT_LINK2
set oam cfm session CFM_DEFAULT_LINK2 level 2
set oam cfm session CFM_DEFAULT_LINK2 maintenance-domain MD_BNG
set oam cfm session CFM_DEFAULT_LINK2 maintenance-association MA_DEFAULT_200
set oam cfm session CFM_DEFAULT_LINK2 continuity-check-interval 1s
set oam cfm session CFM_DEFAULT_LINK2 local-mep 1001
set oam cfm session CFM_DEFAULT_LINK2 remote-mep 2001
set oam cfm session CFM_DEFAULT_LINK2 interface ifl-0/0/1/200
```

```
supervisor@rtbrick.net: cfg> show config oam cfm session
{
  "rtbrick-config:session": [
    {
      "name": "CFM_DEFAULT_LINK1",
      "level": 2,
      "maintenance-domain": "MD_BNG",
      "maintenance-association": "MA_DEFAULT_100",
      "continuity-check-interval": "1s",
      "local-mep": 1000,
      "remote-mep": 2000,
      "interface": "ifl-0/0/0/100"
    },
    {
      "name": "CFM_DEFAULT_LINK2",
      "level": 2,
      "maintenance-domain": "MD_BNG",
      "maintenance-association": "MA_DEFAULT_200",
      "continuity-check-interval": "1s",
      "local-mep": 1001,
      "remote-mep": 2001,
      "interface": "ifl-0/0/1/200"
    }
  ]
}
```

To see related show commands and output, see Show OAM CFM.

Example 2: Point-to-Multipoint CFM Session configuration

The following is an example configuration that shows Point-to-Multipoint CFM sessions on a single interface, that is ifl-0/0/5/0. With this configuration, the interface ifl-0/0/5/0 can run multiple CFM sessions. Each session is configured with a common local MEP (2000) and different remote MEPs (3000 and 4000). It allows the local endpoint to monitor connectivity with multiple remote endpoints on a single interface.

```
set oam cfm session CFM_R3
set oam cfm session CFM_R3 level 2
set oam cfm session CFM_R3 maintenance-domain BNG
set oam cfm session CFM_R3 maintenance-association MA_BNG
set oam cfm session CFM_R3 continuity-check-interval 1s
set oam cfm session CFM_R3 local-mep 2000
set oam cfm session CFM_R3 remote-mep 3000
set oam cfm session CFM_R3 interface ifl-0/0/5/0
set oam cfm session CFM_R4
set oam cfm session CFM_R4 level 2
set oam cfm session CFM_R4 maintenance-domain BNG
set oam cfm session CFM_R4 maintenance-association MA_BNG
set oam cfm session CFM_R4 continuity-check-interval 1s
set oam cfm session CFM_R4 local-mep 2000
set oam cfm session CFM_R4 remote-mep 4000
set oam cfm session CFM_R4 interface ifl-0/0/5/0
```

Example:

```
{
  "rtbrick-config:cfm": {
    "session": [
      {
        "name": "CFM_P2MP_R3",
        "level": 2,
        "maintenance-domain": "BNG",
        "maintenance-association": "MA_BNG",
        "continuity-check-interval": "1s",
        "local-mep": 2000,
        "remote-mep": 3000,
        "interface": "ifl-0/0/5/0"
      },
      {
        "name": "CFM_P2MP_R4",
        "level": 2,
        "maintenance-domain": "BNG",
        "maintenance-association": "MA_BNG",
        "continuity-check-interval": "1s",
        "local-mep": 2000,
        "remote-mep": 4000,
        "interface": "ifl-0/0/5/0"
      }
    ]
  }
}
```

To see related show commands and output, see Show OAM CFM.

Enabling Nexthop Tracking

You can enable Nexthop tracking using the following commands and options.

Syntax:

set instance <instance-name> **oam cfm track** <session-name> [nexthop4 | nexthop6] <ip-address>

Attribute	Description
<instance-name>	Name of the instance.
<session>	Specify the session name.
[nexthop4 | nexthop6]	Specify nexthop4 to trace ipv4 nexthop and specify nexthop6 to track ipv6 nexthop.

API To access the RESTCONF API that corresponds to this CLI, click here.

Example:

The following configuration defines nexthop tracking using CFM sessions. The sessions, CFM_DEFAULT_LINK1 and CFM_DEFAULT_LINK2 are linked to a specific set of next-hop addresses, including both IPv4 and IPv6 addresses. If a CFM session goes down, all the associated next-hops will be considered as unreachable and the routes that uses these next-hops are made unavailable in the forwarding information base.

```
set instance default oam cfm track CFM_DEFAULT_LINK1
set instance default oam cfm track CFM_DEFAULT_LINK1 nexthop4 12.0.1.2
set instance default oam cfm track CFM_DEFAULT_LINK1 nexthop4 182.168.0.20
set instance default oam cfm track CFM_DEFAULT_LINK1 nexthop6 182:168::20
set instance default oam cfm track CFM_DEFAULT_LINK1 nexthop6 fe80::7810:2
set instance default oam cfm track CFM_DEFAULT_LINK2
set instance default oam cfm track CFM_DEFAULT_LINK2 nexthop4 12.1.1.2
set instance default oam cfm track CFM_DEFAULT_LINK2 nexthop4 182.168.0.20
set instance default oam cfm track CFM_DEFAULT_LINK2 nexthop6 182:168::20
set instance default oam cfm track CFM_DEFAULT_LINK2 nexthop6 fe80::7810:2
```

```
supervisor@rtbrick.net: cfg> show config instance default oam cfm
{
  "rtbrick-config:cfm": {
```

```
    "track": [
      {
        "session": "CFM_DEFAULT_LINK1",
        "nexthop4": [
          "12.0.1.2",
          "182.168.0.20"
          ],
        "nexthop6": [
          "182:168::20",
          "fe80::7810:2"
          ]
      },
      {
        "session": "CFM_DEFAULT_LINK2",
        "nexthop4": [
          "12.1.1.2",
          "182.168.0.20"
          ],
        "nexthop6": [
          "182:168::20",
          "fe80::7810:2"
          ]
      }
    ]
  }
}
```

7.1.3. Operational Commands

Show OAM CFM

The command displays the CFM session information.

show oam cfm session <option>

Option	Description
detail	Shows detailed information about CFM sessions.
interface	Shows CFM session details for the specified logical interface.

Example: CFM session

```
supervisor@rtbrick.net: cfg> show oam cfm session
Interface          Maintenance Domain       Maintenance Association  Local MEP
Remote MEP State
ifl-0/0/0/1        MD_BNG                   MA_DEFAULT_100           1000
2000       Up
ifl-0/0/1/1        MD_BNG                   MA_DEFAULT_200           1001
2001       Up
```

Example: CFM session details for a specific interface

```
supervisor@rtbrick.net: cfg> show oam cfm session interface ifl-0/0/0/100
Interface name: ifl-0/0/0/100, CFM state: Up
  Maintenance domain name: MD_BNG, Format: None
    Maintenance association name: MA_DEFAULT_100, Format: Character string
    Continuity check interval: 1s, Loss threshold: 3 Frames
    Local endpoint ID: 1000, Remote endpoint ID: 2000
    CCM packet last sequence received: 7, CCM packet last sequence sent: 55224
    CCM packet received count: 431344, CCM packet transmit count: 55225
    Last error: None
```

Example: Detailed view of CFM session

```
supervisor@rtbrick.net: cfg> show oam cfm session detail
Interface name: ifl-0/0/0/100, CFM state: Up
  Maintenance domain name: MD_BNG, Format: None
    Maintenance association name: MA_DEFAULT_100, Format: Character string
    Continuity check interval: 1s, Loss threshold: 3 Frames
    Local endpoint ID: 1000, Remote endpoint ID: 2000
    CCM packet last sequence received: 7, CCM packet last sequence sent: 55224
    CCM packet received count: 431344, CCM packet transmit count: 55225
    Last error: None
Interface name: ifl-0/0/1/200, CFM state: Up
  Maintenance domain name: MD_BNG, Format: None
    Maintenance association name: MA_DEFAULT_200, Format: Character string
    Continuity check interval: 1s, Loss threshold: 3 Frames
    Local endpoint ID: 1001, Remote endpoint ID: 2001
    CCM packet last sequence received: 7, CCM packet last sequence sent: 55224
    CCM packet received count: 431343, CCM packet transmit count: 55225
    Last error: None
```

Example for Point to Multipoint CFM sessions

```
supervisor@rtbrick.net: cfg> show oam cfm session
Interface          Maintenance Domain       Maintenance Association  Local MEP
Remote MEP State
ifl-0/0/5/0     BNG                      MA_BNG                   2000       3000
Up
ifl-0/0/5/0     BNG                      MA_BNG                   2000       4000
Up
```

Detailed view of Point to Multipoint CFM sessions.

```
supervisor@rtbrick.net: cfg>show oam cfm session detail
Interface name: ifl-0/0/5/0, CFM state: Up
  Maintenance domain name: BNG, Format: None
    Maintenance association name: MA_BNG, Format: Character string
    Continuity check interval: 1s, Loss threshold: 3 Frames
    Local endpoint ID: 2000, Remote endpoint ID: 3000
    CCM packet received count: 0, CCM packet transmit count: 0
    Last error: Continuity-check-interval mismatch
```

```
Interface name: ifl-0/0/5/0, CFM state: Up
  Maintenance domain name: BNG, Format: None
    Maintenance association name: MA_BNG, Format: Character string
    Continuity check interval: 1s, Loss threshold: 3 Frames
    Local endpoint ID: 2000, Remote endpoint ID: 4000
    CCM packet received count: 0, CCM packet transmit count: 0
    Last error: None
```

CFM Clear Command

Clear commands allow to reset operational states.

Syntax:

clear oam cfm statistics <option>

Option	Description
-	Clears all the CFM statistics.
<interface>	Clears statistics for the specified interface.

Example commands:

```
clear oam cfm statistics
clear oam cfm statistics interface <interface>
```

7.2. BFD

7.2.1. Bidirectional Forwarding Detection Overview

BFD, or Bidirectional Forwarding Detection, is a fast failure detection protocol that enables RBFS devices to identify broken links quickly. This quick detection helps to ensure fast rerouting and minimizes downtime.

BFD swiftly identifies network failures between neighboring devices using a simple hello mechanism. BFD enabled RBFS devices establish a session and exchange BFD control packets at regular intervals. If a device stops receiving BFD packets from its neighbor within the predefined detection time, it assumes that the path has failed. This failure information is then communicated to routing protocols such as OSPF, BGP, or IS-IS, allowing these protocols to reroute traffic immediately.

Routing protocols, such as OSPF and BGP, rely on hello and dead timers that can range from 1 to 10 seconds to detect failures. BFD ensures rapid convergence by detecting failures almost instantly and signaling routing protocols to switch paths quickly.

Imagine where Router A is connected to Router B. The routing protocol, such as OSPF, indicates that the neighbor is operational. However, due to a hardware fault, packets cannot actually be transmitted from Router A's interface to Router B. Without BFD, it could take several seconds for OSPF to recognize this problem. With BFD, the loss of BFD packets can signal a forwarding path failure swiftly.

This BFD implementation offers operational visibility and provides details such as session state (up/down/init), Timers (transmit interval, receive interval, detection time), Detection multiplier (how many missed packets before declaring down), packet statistics (sent/received counts) and last-down reason (for example, timeout, admin shutdown, remote fault).

Routing applications in RBFS can use BFD functionality through the OAMD infrastructure. OAM Daemon provides an interface that allows applications to create and delete BFD sessions.

Restrictions for Bidirectional Forwarding Detection

- Only 'Asynchronous' mode is supported. 'Demand' and 'Echo' modes are not supported.
- Currently, BFD sessions are supported on static routes, BGP, IS-IS, and OSPF protocols.
- Authentication is not supported.
- BFD sessions are limited only to single-hop.
- BFD currently supports only IPv4 and IPv6 address families, not MPLS.
- For a dual-stack IS-IS neighbor, it establishes two BFD sessions, one for IPv4 and another for IPv6 endpoints based the IS-IS configuration. If either BFD session goes down, the dual-stack IS-IS adjacency is immediately brought down.

Supported Platforms

Not all features are necessarily supported on each hardware platform. Refer to the

Platform Guide for the features and the sub-features that are or are not supported by each platform.

7.2.2. BFD Configuration

Configuration Syntax and Commands

The following sections describe the Bidirectional Forwarding Detection configuration syntax and commands.

A static BFD session is configured by explicitly setting the local and peer IP addresses and interfaces along with the BFD parameters, such as 'transmit' and 'receive' intervals and 'detection multipliers'. The session is established directly between the two endpoints without depending on any routing protocol.

In contrast, a dynamic BFD session is automatically created and managed by a routing protocol, such as BGP.

Static BFD Session Configuration

A BFD session can be established through static configuration.

Syntax

set oam bfd session <session name>

Attribute	Description
detect-multiplier	The minimum number of consecutive BFD packets that must be missed before the BFD session is declared down. Range 2 - 255. Default 3.
interface	Logical interface name.
local-v4-address	Local IPv4 address. This is the IPv4 source address of BFD packets configured on the interface used in the session.
local-v6-address	Local IPv6 address. This is the IPv6 source address of BFD packets configured on the interface used in the session.

Attribute	Description
peer-v4-address	Peer IPv4 address.
peer-v6-address	Peer IPv6 address.
receive-interval	The receive interval is the amount of time (in milliseconds) that an RBFS device waits to receive a BFD control packet from its peer. Range: 100-10000. Default: 1000 milliseconds
transmit-interval	The transmit interval is the minimum amount of time (in milliseconds) that an RBFS device transmits BFD control packets to its peer. Range: 100 - 10000. Default: 1000 milliseconds.

This configuration establishes two BFD sessions, named BFD_V4_IFP1_LINK1 and BFD_V6_IFP1_LINK1, for IPv4 and IPv6, respectively, on the same interface (ifl-0/0/0/0). Both sessions are set to a transmit/receive interval of 1000 milliseconds, meaning they exchange BFD packets once per second to quickly detect failures.

The peer IPv4 address, which is the neighbor's IP address for BFD packets, is specified as 192.0.2.2, while the local IPv4 address is designated as 192.0.2.1. For IPv6, the peer address is set as 2001:db8::2, and the local address is specified as 2001:db8::1.

If no packet is received within the hold interval (calculated as receive interval × detect multiplier), the BFD session is declared down.

```
set oam bfd session BFD_V4_IFP1_LINK1
set oam bfd session BFD_V4_IFP1_LINK1 peer-v4-address 192.0.2.2
set oam bfd session BFD_V4_IFP1_LINK1 local-v4-address 192.0.2.1
set oam bfd session BFD_V4_IFP1_LINK1 transmit-interval 1000
set oam bfd session BFD_V4_IFP1_LINK1 receive-interval 1000
set oam bfd session BFD_V4_IFP1_LINK1 interface ifl-0/0/0/0
set oam bfd session BFD_V6_IFP1_LINK1
set oam bfd session BFD_V6_IFP1_LINK1 peer-v6-address 2001:db8::2
set oam bfd session BFD_V6_IFP1_LINK1 local-v6-address 2001:db8::1
set oam bfd session BFD_V6_IFP1_LINK1 transmit-interval 1000
set oam bfd session BFD_V6_IFP1_LINK1 receive-interval 1000
set oam bfd session BFD_V6_IFP1_LINK1 interface ifl-0/0/0/0
```

```
{
  "rtbrick-config:session": [
    {
      "name": "BFD_V4_IFP1_LINK1",
      "peer-v4-address": "192.0.2.2",
```

```
      "local-v4-address": "192.0.2.1",
      "transmit-interval": 1000,
      "receive-interval": 1000,
      "interface": "ifl-0/0/0/0"
    },
    {
      "name": "BFD_V6_IFP1_LINK1",
      "peer-v6-address": "2001:db8::2",
      "local-v6-address": "2001:db8::1",
      "transmit-interval": 1000,
      "receive-interval": 1000,
      "interface": "ifl-0/0/0/0"
    }
  ]
}
```

Enabling BFD for Static Routes

RBFS supports tracking static routes through static BFD sessions. When a static BFD session moves to the down state, all the static routes associated with that session are automatically removed from the system. This ensures quick and reliable route failover.

To enable this feature, you must configure a static conditional profile with:

- compare-type : bfd-session-up (It means the condition is satisfied only when the BFD session is UP).
- match-bfd-session (the specific BFD session that you want to track).

After creating the conditional profile, attach it to the static routes that need monitoring. Once applied, these routes will remain active only while the corresponding static BFD session is operational.

Static BFD Conditional Profile Configuration

Syntax:

Static Route Configuration with Conditional Profile:

set instance <instance-name> **static conditional-profile** <conditional-profile-name> **compare-type bfd-session-up**

set instance <instance-name> **static conditional-profile** <conditional-profile-name> **match-bfd-session** <bfd-session-name>

Linking Conditional Profile to Static Route:

set instance <instance-name> **static route afi** <prefix> **safi** <safi> **nexthop-profile** <nexthop-profile-name> **conditional-profile** <conditional-profile-name>

Attribute	Description
<instance-name>	Name of the instance.
<nexthop-profile-name>	Name of the next-hop profile.
<conditional-profile-name>	Name of the conditional profile.
<bfd-session-name>	Name of the BFD session.

This configuration creates a conditional profile 'cp1' for static routes. The profile is used to track the status of a specific BFD session. The 'compare-type' is defined as bfd-session-up, it indicates the condition is satisfied only when the BFD session is UP. The match-bfd-session is specified as BFD_V4_IFP1_LINK0. Static routes that use this conditional profile will stay installed only when the BFD session 'BFD_V4_IFP1_LINK0' is UP. If the BFD session goes down, the routes are automatically withdrawn.

The route uses a next-hop profile np1 and is associated to the conditional profile 'cp1'. It means the route will be installed only if the condition in 'cp1' is met.

This configuration is used to ensure the static route is only installed when the monitored path is reachable. If the BFD session S1 goes down, the route is automatically withdrawn. It prevents traffic from being sent down an inactive path.

```
set instance default static route ipv4 192.0.2.26/32 unicast np1 conditional-
profile cp1
set instance default static nexthop-profile np1 nexthop 198.51.100.2
set instance default static conditional-profile cp1 compare-type bfd-session-up
set instance default static conditional-profile cp1 match-bfd-session
BFD_V4_IFP1_LINK0
```

```
{
  "rtbrick-config:static": {
    "route": {
      "ipv4": [
        {
```

```
          "prefix4": "192.0.2.26/32",
          "safi": "unicast",
          "nexthop-profile": "np1",
          "conditional-profile": [
            "cp1"
          ]
        }
      ]
    },
    "nexthop-profile": [
      {
        "name": "np1",
        "nexthop": "198.51.100.2"
      }
    ],
    "conditional-profile": [
      {
        "name": "cp1",
        "compare-type": "bfd-session-up",
        "match-bfd-session": "BFD_V4_IFP1_LINK0"
      }
    ]
  }
}
```

BFD Profile Configuration

A BFD profile contains the parameters that controls the behavior of BFD sessions. You can create BFD profiles that allow you to define common BFD parameters (such as transmit and receive intervals, detect multipliers) in the profile and associate them with the BGP, OSPF or IS-IS protocols.

Syntax

set oam bfd profile <profile-name> <attribute> <value>

Attribute	Description
<profile name>	Name of the BFD profile.
detect-multiplier	The minimum number of consecutive BFD packets that must be missed before the BFD session is declared down. Range 2 - 255. Default 3.
receive-interval	The receive interval is the minimum amount of time (in milliseconds) that an RBFS device waits to receive a BFD control packet from its peer. Range: 100 - 10000. Default: 1000 milliseconds

Attribute	Description
transmit-interval	The transmit interval is the minimum amount of time (in milliseconds) that an RBFS device transmits BFD control packets to its peer. Range: 100- 10000. Default: 1000 milliseconds.

Example: BFD profile configuration

The following configuration creates a BFD profile named 'BGP_BFD_PROFILE1'. In this configuration, both the transmit interval and the receive interval are set to 1000 milliseconds, while the detect multiplier is defined as 3. It also defines the number of consecutive missed BFD packets required to declare the session as down.

```
set oam bfd profile BGP_BFD_PROFILE1
set oam bfd profile BGP_BFD_PROFILE1 transmit-interval 1000
set oam bfd profile BGP_BFD_PROFILE1 receive-interval 1000
set oam bfd profile BGP_BFD_PROFILE1 detect-multiplier 3
```

```
{
  "rtbrick-config:profile": [
    {
      "name": "BGP_BFD_PROFILE1",
      "transmit-interval": 1000,
      "receive-interval": 1000,
      "detect-multiplier": 3
    }
  ]
}
```

Attaching BFD Profile to BGP

After creating a BFD profile, you can attach the profile to BGP prot

Syntax

set instance <instance-name> **protocol bgp peer interface | IPv4 | IPv6** <interface name | local address & peer address> **bfd profile** <profile-name>

Attribute	Description
<profile name>	Name of the BFD profile.

Attribute	Description
interface	Name of the interface.
local address	Local IPv4 and IPv6 address.
peer address	Peer IPv4 and IPv6 address.

The following configuration attaches a BFD for different BGP peers in the default routing instance. The BFD profile named 'BGP_BFD_PROFILE1' is attached to the BGP peer interface 'ifl-0/0/0/6, IPv4 and IPv6 addresses (IPv4 local: 192.0.2.2 , peer: 192.0.2.1 and IPv6 local: 2001:db8::2, peer 2001:db8::1). This means that the BGP peer with these IP addresses will utilize the BFD parameters specified in BGP_BFD_PROFILE1. Any BGP peer that connects to this interface will automatically inherit the BFD settings. Once a BFD profile is attached to a peer group, all peers within that group will receive those BFD parameters.

```
set instance default protocol bgp peer interface ifl-0/0/0/6 bfd-profile
BGP_BFD_PROFILE1
set instance default protocol bgp peer ipv4 192.0.2.2 192.0.2.1 bfd-profile
BGP_BFD_PROFILE1
set instance default protocol bgp peer ipv6 2001:db8::2 2001:db8::1 bfd-profile
BGP_BFD_PROFILE1
```

```
{
  "rtbrick-config:peer": {
    "interface": [
      {
        "name": "ifl-0/0/0/6",
        "bfd-profile": "BGP_BFD_PROFILE1",
        "peer-group": "ipv6_bgp_ll"
      }
    ],
    "ipv4": [
      {
        "peer-address": "192.0.2.2",
        "update-source": "192.0.2.1",
        "bfd-profile": "BGP_BFD_PROFILE1",
        "peer-group": "ipv4_bgp"
      }
    ],
    "ipv6": [
      {
        "peer-address": "2001:db8::2",
        "update-source": "2001:db8::1",
        "bfd-profile": "BGP_BFD_PROFILE1",
        "peer-group": "ipv6_bgp"
      }
    ]
  }
}
```

Attaching BFD Profile on IS-IS Interface

Once the BFD profile is created, you can attach the BFD profile on IS-IS interface.

Syntax

set instance <instance-name> **protocol isis interface**<interface-name> **bfd-profile** <profile-name>

Attribute	Description
<instance-name>	Name of the instance.
interface-name	Name of the interface.
<profile-name>	Name of the BFD profile.

Example:

This configuration applies the BFD profile 'BFD_PROFILE_100MSx2' to the IS-IS interface 'ifl-0/0/0/0' so that IS-IS can detect adjacency link failures within 200 milliseconds.

```
set instance default protocol isis interface ifl-0/0/0/0
set instance default protocol isis interface ifl-0/0/0/0 bfd-profile
BFD_PROFILE_100MSx2
```

```
{
  "rtbrick-config:interface": [
    {
      "name": "ifl-0/0/0/0",
      "bfd-profile": "BFD_PROFILE_100MSx2"
    }
  ]
}
```

Enabling BFD for OSPFv2

Once the BFD profile is created, you can attach the BFD profile on the OSPFv2 interface.

Syntax:

set instance <instance-name> **protocol ospf address-family ipv4 area** <area-id> **interface** <interface-name> **bfd-profile** <profile-name>

Attribute	Description
<instance-name>	Name of the instance.
<area-id>	OSPFv2 area identifier.
<interface-name>	Name of the interface.
<profile-name>	Name of the BFD profile.

Example:

This configuration applies the BFD profile 'PROTOCOL_BFD_PROFILE5' to the OSPFv2 area 0.0.0.0 interface 'ifl-0/0/0/11', enabling OSPFv2 to detect neighbor link failures within 200 milliseconds.

```
set instance default protocol ospf address-family ipv4 area 192.0.2.0 interface
ifl-0/0/0/11
set instance default protocol ospf address-family ipv4 area 192.0.2.0 interface
ifl-0/0/0/11 bfd-profile PROTOCOL_BFD_PROFILE5
```

```
{
  "rtbrick-config:interface": [
    {
      "name": "ifl-0/0/0/11",
      "bfd-profile": "PROTOCOL_BFD_PROFILE5"
    }
  ]
}
```

Enabling BFD for OSPFv3

Once the BFD profile is created, you can attach the BFD profile on the OSPFv3 interface.

Syntax:

set instance <instance-name> **protocol ospf address-family ipv6 instance-id** <instance-id> **area** <area-id> **interface** <interface-name> **bfd-profile** <profile-name>

Attribute	Description
<instance-name>	Name of the instance.
<area-id>	OSPFv2 area identifier.
<instance-id>	IPv6 instance identifier.
<interface-name>	Name of the interface.
<profile-name>	Name of the BFD profile.

Example:

This configuration applies the BFD profile PROTOCOL_BFD_PROFILE5 to the OSPFv3 interface ifl-0/0/0/11, enabling the interface to use the profile's defined BFD timers and detection parameters. It is configured under the IPv6 address family with instance-id 0 in area 0.0.0.0, ensuring OSPFv3 adjacencies on this interface use consistent BFD behavior.

```
set instance default protocol ospf address-family ipv6 instance-id 0 area
192.0.2.1 interface ifl-0/0/0/11
set instance default protocol ospf address-family ipv6 instance-id 0 area
192.0.2.1 interface ifl-0/0/0/11 bfd-profile PROTOCOL_BFD_PROFILE5
```

```
{
  "rtbrick-config:interface": [
    {
      "name": "ifl-0/0/0/11",
      "bfd-profile": "PROTOCOL_BFD_PROFILE5"
    }
  ]
}
```

Control Plane QoS Outbound Marking for BFD

You can configure Control Plane QoS outbound marking for BFD packets by specifying the DSCP value for BFD packets based on the routing protocol.

Syntax:

set forwarding-options class-of-service control-plane-qos outbound-marking protocol <protocol> <tos> ifp <ifp> codepoint <codepoint>

Attribute	Description
<protocol>	Specifies the routing protocol for which to configure the DSCP marking for BFD packets.
<tos>	Specifies whether to use TOS for marking.
<codepoint>	Specifies the DSCP codepoint value to be used for marking BFD packets.

Example:

The following command configures control-plane QoS so that all outgoing BFD packets sent by the device are remarked with a specific type of service (ToS) codepoint value 100.

```
set forwarding-options class-of-service control-plane-qos outbound-marking
protocol bfd tos codepoint 100
```

```
supervisor@rtbrick.net: cfg> show config forwarding-options class-of-service
control-plane-qos outbound-marking protocol bfd
{
  "rtbrick-config:protocol": [
    {
      "protocol": "bfd",
      "remark-type": "tos",
      "codepoint": 100
    }
  ]
}
```

7.2.3. BFD Operational Commands

BFD Show Commands

The command displays the BFD session information.

show oam bfd session <option>

Option	Description
-	Without any option, it displays all the BFD session information.

Option	Description
history	BFD session history
peer	Peer address of BFD session
verbose	BFD session verbose.
session	Shows the session information.
detail	Shows detailed information about BFD sessions.

Example: The output lists BGP neighbor relationships with each peer's address, remote AS number, state, uptime, and the number of prefixes exchanged.

```
supervisor@rtbrick.net: cfg> show bgp peer Instance: default
  Peer                        Remote AS    State         Up/Down Time
PfxRcvd              PfxSent
  12.0.4.2                    4200000001   Established   0d:00h:04m:14s        2
2
  12:0:5::2                   4200000001   Established   0d:00h:07m:34s        0
2
  fe80::7845:f00:1c0:3        4200000001   Established   0d:00h:04m:17s        0
2
```

Example: The otput shows status of active BFD sessions with session state, and the transmit and receive intervals. All sessions are Up, exchanging BFD packets every 1000 ms with their respective peers.

```
supervisor@rtbrick.net: cfg> show oam bfd session
Peer                           State      Transmit-interval(ms)  Receive-
interval(ms)
12.0.4.2                       Up         1000                   1000
12:0:5::2                      Up         1000                   1000
fe80::7845:f00:1c0:3           Up         1000                   1000
```

Example: The output shows the IS-IS neighbor interface is up at Level 1 over a point-to-point link and the adjacency has been established from the specified time and will expire in the specified time (expires).

```
supervisor@rtbrick.net: cfg> show isis neighbor interface ifl-0/0/0/0
Instance: default
  Interface       System              Level   State   Type   Up since
Expires
  ifl-0/0/0/0     64496               L1      Up      P2P    Wed Oct 29 06:17:23
in 18s 28274us
```

Example: This output shows the ISIS Level-1 adjacency on interface ifl-0/0/0/0 with

the specified neighbor which is Up in P2P mode. The session has been established from the specified time with 32 transitions. The BFD event is marked as 1.

```
supervisor@rtbrick.net: cfg> show isis neighbor interface ifl-0/0/0/0 detail
Instance: default
  System: 64496, Interface: ifl-0/0/0/0
    State: Up, Level:L1, Adjacency type: P2P
    Circuit type: L1, Hold time: 30.0s, Expiry time: in 27s 371715us
    Local IPv4 address: 192.0.2.1, Remote IPv4 address: 192.0.2.2, Unnumbered:
False
    Local IPv6 address: 2001:db8::1, Remote IPv6 address: 2001:db8::2
    Up since: Wed Oct 29 06:17:23 GMT +0000 2025, Last down reason: BFD down
    Last transition: 2025-10-29T06:17:23.517920+0000, Number of transitions: 32
    Error counters:
      Level mismatch: 0, Area mismatch: 0, System ID: 0, Subnet mismatch: 0
      Hold timeout: 4, Neighbor down: 6, Interface down: 0, Admin reset: 0, BFD
down: 1
      Interface configuration: 0, Area configuration: 0, Other: 0
```

Example: The output shows two BFD sessions (IPv4 and IPv6) are currently 'Up' with both configured for 100 ms transmit and receive intervals.

```
supervisor@rtbrick.net: cfg> show oam bfd session
Peer                           State      Transmit-interval(ms)  Receive-
interval(ms)
192.0.2.1                     Up         100                    100
2001:db8::1                   Up         100                    100
```

Example: The output shows both IPv4 and IPv6 BFD sessions on the interface are Up, using 100 milliseconds transmit/receive intervals and a 200 milliseconds hold time interval.

```
supervisor@rtbrick.net: cfg> show oam bfd session detail
Peer address: 12.0.4.2, Local address: 12.0.4.1
  State: Up, Interface: -, Instance : default
    Local discriminator: 1005, Remote discriminator: 1005
      Transmit interval: 1000ms, Receive interval: 1000ms, Detect time multiplier:
3
      Hold interval: 3000ms
      Diagnostic code: No Diagnostic
      Last transition time: 2025-11-03T09:55:58.768883+0000, Flap count: 0
Peer address: 12:0:5::2, Local address: 12:0:5::1
  State: Up, Interface: -, Instance : default
    Local discriminator: 1006, Remote discriminator: 1006
      Transmit interval: 1000ms, Receive interval: 1000ms, Detect time multiplier:
3
      Hold interval: 3000ms
      Diagnostic code: No Diagnostic
      Last transition time: 2025-11-03T09:52:35.502555+0000, Flap count: 1
Peer address: fe80::7845:f00:1c0:3, Local address: fe80::7810:df00:1c0:1
  State: Up, Interface: hostif-0/0/1/1, Instance : default
    Local discriminator: 1004, Remote discriminator: 1004
```

```
      Transmit interval: 1000ms, Receive interval: 1000ms, Detect time multiplier:
3
      Hold interval: 3000ms
      Diagnostic code: No Diagnostic
      Last transition time: 2025-11-03T09:55:51.865513+0000, Flap count: 1
```

Example output for OSPFv2 and OSPFv3 neighbor and the corresponding BFD session.

```
```
supervisor@rtbrick.net: cfg> show ospf neighbor interface ifl-0/0/0/11
Instance: default, Address family: ipv4
  Address   Interface   Router   Area   State
Priority DR   BDR   Uptime   Expires
  192.0.2.2   ifl-0/0/0/11   198.51.100.20   0.0.0.0   Full   1
192.0.2.2   192.0.2.1   0d:00h:00m:25s 40s
Instance: default, Address family: ipv6, Instance ID: 0
  Address   Interface   Router   Area   State
Priority DR   BDR   Uptime   Expires
  2001:DB8::2   ifl-0/0/0/11   198.51.100.20   0.0.0.0   Full   1
2001:DB8::10   2001:DB8::20   0d:00h:00m:31s 39s
```

Example for BFD session associated with OSPFv2 neighbor.

```
supervisor@rtbrick.net: cfg> show oam bfd session peer 192.0.2.2
Peer                          State      Transmit-interval(ms)  Receive-
interval(ms)
192.0.2.2                     Up         100                    100
```

Detailed view of BFD session associated with OSPFv2 neighbor.

```
supervisor@rtbrick.net: cfg> show oam bfd session peer 192.0.2.2 detail
Peer address: 192.0.2.2, Local address: 192.0.2.1
  State: Up, Interface: ifl-0/0/0/11, Instance : default
  Clients: ospfv2
  Local discriminator: 1061, Remote discriminator: 2978
    Transmit interval: 100ms, Receive interval: 100ms, Detect time multiplier: 3
    Hold interval: 300ms
    Diagnostic code: No Diagnostic
    Last transition time: 2025-11-14T05:35:02.675593+0000, Flap count: 1
```

Example for BFD session associated with OSPFv3 neighbor.

```
supervisor@rtbrick.net: cfg> show oam bfd session peer 2001:db8::9810:21
Peer                          State      Transmit-interval(ms)  Receive-
interval(ms)
2001:db8::9810:21             Up         100                    100
```

Detailed view of BFD session associated with OSPFv3 neighbor.
```

```
supervisor@rtbrick.net: cfg> show oam bfd session peer 2001:DB8::1 detail
Peer address: 2001:DB8::1, Local address: 2001:DB8::2
  State: Up, Interface: ifl-0/0/0/11, Instance : default
  Clients: ospf
  Local discriminator: 1067, Remote discriminator: 2985
    Transmit interval: 100ms, Receive interval: 100ms, Detect time multiplier: 3
    Hold interval: 300ms
    Diagnostic code: No Diagnostic
    Last transition time: 2025-11-14T05:35:07.606463+0000, Flap count: 1
```

The following example output shows that the BFD session with peer '192.0.2.2' is Up on interface ifl-0/0/0/0, tracked by the static client, with matching discriminators and stable timers, and has transitioned state times.

```
supervisor@rtbrick.net: cfg> show oam bfd session peer 192.0.2.2 detail
Peer address: 192.0.2.2, Local address: 192.0.2.1
  State: Up, Interface: ifl-0/0/0/0, Instance : -
  Clients: static
  Local discriminator: 1000, Remote discriminator: 1000
    Transmit interval: 500ms, Receive interval: 500ms, Detect time multiplier: 3
    Hold interval: 3000ms
    Diagnostic code: No Diagnostic
    Last transition time: 2025-11-18T10:05:39.586178+0000, Flap count: 8
```

The following example output shows that the static route 192.0.2.26/32 is installed in both IPv4 unicast and labeled-unicast tables with next hop 198.51.100.2 via ifl-0/0/0/0, with a preference of 2.

```
supervisor@rtbrick.net: cfg> show route source static prefix 192.0.2.26/32
Flags: & - Imported
Instance: default, AFI: ipv4, SAFI: unicast
Flags  Prefix/Label                              Source           Pref  Next Hop
Outgoing Interface
       192.0.2.26/32                           static            2
198.51.100.2                 ifl-0/0/0/0
Instance: default, AFI: ipv4, SAFI: labeled-unicast
Flags  Prefix/Label                              Source           Pref  Next Hop
Label   Outgoing Interface
       192.0.2.26/32                           static            2
198.51.100.2          -       ifl-0/0/0/0
```

BFD Clear Commands

This command resets the existing BFD sessions.

Syntax

clear oam bfd session <option>

Option	Description
-	Without any option, the commands clears all the BFD session details.
session <session-name>	Clears the specified BFD session.
peer-address <peer-address> local-address <local-address>	Clears BFD session for the specified peer.

Example commands:

```
clear oam bfd session
clear oam bfd session peer-address <peer-address> local-address <local-address>
clear oam bfd session session-name <bfd-session-name>
```

7.3. Ping and Traceroute

7.3.1. Ping and Traceroute Commands

Overview

RBFS provides the following ping and traceroute functionalities:

- IP Ping
- IP Ping over an MPLS Transport
- IP Traceroute
- IP Traceroute over an MPLS Transport
- MPLS LSP Ping
- MPLS LSP Traceroute

IP Ping

IP Ping is a tool that tests network reachability by sending ICMP echo requests. It provides information about the round-trip time of the packets and their status. PI

Ping tests network reachability by sending ICMP echo requests. It provides information about the round-trip time (RTT) of the packets and their status. Ping is primarily used to verify general IP connectivity and diagnose basic network issues.

This utility performs a basic connectivity test using ICMP Echo Request and Reply messages. It checks the reachability of IP addresses between two endpoints, measures round-trip time, and assesses packet loss. The process works by sending ICMP Echo Requests from a source to a destination IP address. If the destination is reachable, it responds with Echo Reply messages.

IP Ping over an MPLS Transport

RBFS support ping utility that pings from one IP endpoint to another endpoint within an MPLS network. This ping checks the IP connectivity across an MPLS backbone and determines whether MPLS forwarding allows the IP packet to reach its destination. The originating device send standard ICMP packets. These packets are label-switched within the MPLS core and are decapsulated at the egress edge router before reaching the destination. This method is used to validate Layer 3 VPN/IP reachability through an MPLS transport network.

IP Traceroute

IP Traceroute is a utility that is used to get information about the hop-by-hop path IP packets take between two devices. It identifies each router in the sequence and measures the latency for every hop. It can detect routing loops or points of packet loss. Traceroute operates by sending IP packets (using UDP, ICMP, or TCP) with progressively increasing Time-to-Live (TTL) values. Each router that decrements the TTL responds with a 'TTL exceeded' message, providing its address. Traceroute is useful for visualizing the exact route the traffic traverse across an IP network.

IP Traceroute over an MPLS Transport

IP Traceroute over an MPLS Transport allows you to trace an IP path between two endpoints when the underlying network uses MPLS for forwarding. The traceroute is initiated at the IP layer, the packets are transported through the MPLS core using label switching. It enables to understand how IP packets traverse an MPLS-based infrastructure and ensures that the IP reachability across the MPLS backbone. This utility allows to validate end-to-end connectivity across an MPLS core, especially in environments where IP traffic is tunneled or carried over label-switched paths.

It helps identify forwarding issues, pinpoint bottlenecks or failures within the MPLS transport, and verify correct label handling by transit routers. It provides visibility into the forwarding behavior of IP packets across the MPLS cloud, IP Traceroute over MPLS and enhances troubleshooting.

MPLS LSP Ping

RBFS supports MPLS LSP (Label Switched Path) Ping that enables administrators to verify an LSP. LSP Ping works by sending packets through chosen LSP to a specific destination (remote endpoint) and checks for a response. It helps to identify if a Label Switched Path is disrupted.

A labeled packet (echo request) is sent towards a destination FEC to verify that this packet terminates at the correct egress LSR that services the FEC. If the egress node's Echo Reply message is received, it confirms that the LSP is established successfully.



MPLS LSP ping currently supports IS-IS for both IPv4 and IPv6 SID-Index, as well as LDP protocol for IPv4 and IPv6 FECs.

MPLS LSP Traceroute

The MPLS LSP Traceroute utility is designed to verify the label switch path by sending MPLS Echo Request packets. It uses the Time-to-Live (TTL) mechanism to determine how many MPLS hops an MPLS packet goes through. This utility can map the route a packet takes to its destination and provides information about each hop, including the latency at each point.

As each Label Switching Router (LSR) along the path receives the packet, it decrements the MPLS TTL. When the TTL reaches 1, the router sends back an MPLS Echo Reply. The source router then sends additional MPLS Echo Request packets with TTL values incrementing from 2, 3, and so on. Each time, a different LSR in the path responds as the TTL expires. This process continues until the egress LSR is reached.



MPLS LSP traceroute supports IS-IS for both IPv4 and IPv6 SID-Index, as well as LDP for both IPv4 and IPv6 FECs.

Supported Platforms

Not all features are necessarily supported on each hardware platform. Refer to the *Platform Guide* for the features and the sub-features that are or are not supported by each platform.

7.3.2. Ping and Traceroute Operational Commands

IP Ping

The IP ping utility is used to test the reachability of a destination IP address and to measure the time taken for packets to travel between the source and the destination.

IP Ping in the Default Instance

The ping command allows you to ping to a destination to check if a device is reachable. When issued in the default instance, the command validates reachability using the default routing table.

Syntax

ping <destination_ip> **afi ipv4**
ping <destination_ip> **count** [1 - 65535]
ping <destination_ip> **do-not-fragment**
ping <destination_ip> **exit-interface** <exit_interface>
ping <destination_ip> **instance** <instance>
ping <destination_ip> **interval** [0.001 - 60.000]
ping <destination_ip> **safi** [**unicast** | **multicast** | **labeled-unicast**]
ping <destination_ip> **size** [8 - 32768]
ping <destination_ip> **source-interface** <source>
ping <destination_ip> **source-ip** <source_ip>
ping <destination_ip> **tos** [0 - 255]
ping <destination_ip> **ttl** [1 - 255]

destination-ip	**Specify the IPv4 destination IP address to ping.**
interface	Specify the source interface used to send the ping packets.

destination-ip	**Specify the IPv4 destination IP address to ping.**
count	Number of ping packets to send. (Default: 5)
do-not-fragment	Sets the do-not-fragment (DF) bit in the IP packet header.
interval	Time interval between packets in seconds. (Default: 1 second).
safi	Subsequent address family identifier. Supported options include 'unicast', 'multicast', and 'labeled-unicast'. Default is 'unicast'.
size	Size of the ping packet in bytes. (Default: 60 bytes).
source-ip	IPv4 address to be used as the source of the ping packets.
ttl	Time-to-live value applied to outgoing packets. Default value is 255.
tos	Type of Service field used for marking packets. Applicable to IP header only. Default value 0.
exit-interface	Enables to force ICMP echo requests through the specified exit interface if route is resolved via that interface.

Example:

The following ping command sends ICMP echo requests (in the default instance) to a IPv4 destination address to verify reachability and measures round-trip latency. The output shows a response received from the destination that includes the icmp_seq (sequence number of the request), ttl (time-to-live value of the returned packet) and time (round-trip latency in milliseconds). The statistics summary displays the number of packets sent/received and the packet-loss percentage, indicating overall connectivity quality.

```
admin@rtbrick: op> ping 198.51.100.111
68 bytes from 198.51.100.111: icmp_seq=1 ttl=64 time=11.8707 ms
68 bytes from 198.51.100.111: icmp_seq=2 ttl=64 time=1.9824 ms
68 bytes from 198.51.100.111: icmp_seq=3 ttl=64 time=5.0726 ms
68 bytes from 198.51.100.111: icmp_seq=4 ttl=64 time=5.6529 ms
68 bytes from 198.51.100.111: icmp_seq=5 ttl=64 time=10.6588 ms
Statistics: 5 sent, 5 received, 0% packet loss
```

To access the RESTCONF API that corresponds to this CLI, click here.

IP Ping in a Specific Instance and AFI/SAFI

This command enables you to send ping requests to a destination within a selected routing instance or VRF, rather than the default global instance. You can also choose the required address family (IPv4 or IPv6). You can verify connectivity to check reachability issues in multi-VRF deployments.

Syntax

ping <destination_ip> **afi ipv4**
ping <destination_ip> **count** <1 - 65535>
ping <destination_ip> **do-not-fragment**
ping <destination_ip> **instance** <instance>
ping <destination_ip> **interval** <0.001 - 60.000>
ping <destination_ip> **safi** [**unicast** | **multicast** | **labeled-unicast**]
ping <destination_ip> **size** <8 - 32768>
ping <destination_ip> **source-interface** <source>
ping <destination_ip> **source-ip** <source_ip>
ping <destination_ip> **tos** <0 - 255>
ping <destination_ip> **ttl** <1 - 255>

destination-ip	**IPv4 destination address to ping.**
instance-name	Name of the instance in which the ping must be executed.
afi	Address Family Identifier.
safi	Subsequent address family identifier. Supported options include 'unicast', 'multicast', and 'labeled-unicast'. Default is 'unicast'
interface	Source interface used to send the ping packets.
count	Number of ping packets to transmit. (Default: 5).
do-not-fragment	Set the do-not-fragment (DF) bit in IP packet header.
interval	Time interval between packets in seconds. (Default: 1 second).

destination-ip	**IPv4 destination address to ping.**
size	Size of the ping packet in bytes. (Default: 60 bytes).
source-ip	IPv4 address to be used as the source of the ping packets.
ttl	Time-to-live value applied to outgoing packets. Default value is 255.
tos	Type of Service field used for marking packets. Applicable to IP header only. Default value is 0.



AFI and SAFI are optional attributes. If they are not explicitly specified, the system defaults to AFI 'IPv6' and SAFI 'unicast'.

Example:

The following example shows how to ping the destination address 198.51.100.80 within the routing instance vrf1. This command specifies the address family as IPv4 and sets the subsequent address family identifier to labeled-unicast. It verifies connectivity when MPLS labels are used for forwarding traffic within the network. The output displays the reply packet size, sequence number (icmp_seq), returned time-to-live (ttl), and round-trip time (time). The output also shows that all 5 packets were received with no packet loss, indicating that the destination is reachable over the labeled IPv4 path.

```
admin@rtbrick: op> ping 198.51.100.80 instance vrf1 afi ipv4 safi labeled-unicast
68 bytes from 198.51.100.80: icmp_seq=1 ttl=64 time=18.1306 ms
68 bytes from 198.51.100.80: icmp_seq=2 ttl=64 time=32.1058 ms
68 bytes from 198.51.100.80: icmp_seq=3 ttl=64 time=19.8205 ms
68 bytes from 198.51.100.80: icmp_seq=4 ttl=64 time=20.0144 ms
68 bytes from 198.51.100.80: icmp_seq=5 ttl=64 time=32.0085 ms
Statistics: 5 sent, 5 received, 0% packet loss
```



To access the RESTCONF API that corresponds to this CLI, click here.

IPv6 Ping

The IPv6 ping utility is used to verify the reachability of an IPv6 destination by sending ICMPv6 echo requests. It helps to check IPv6 connectivity and measure basic round-trip delay. It is useful for troubleshooting IPv6 networks.

IPv6 Ping in the Default Instance

The ping command allows you to ping to an IPv6 destination to check an IPv6 destination in the default routing instance. It helps to verify whether a device is reachable over IPv6 and provides basic round-trip time and connectivity information.

Syntax:

ping <destination_ipv6> **afi ipv6**
ping <destination_ipv6> **count** <1-65535>
ping <destination_ipv6> **instance** <instance>
ping <destination_ipv6> **interval** <0.001-60.000>
ping <destination_ipv6> **safi** <unicast | multicast | labeled-unicast>
ping <destination_ipv6> **size** <8 - 32768>
ping <destination_ipv6> **source-interface** <source>
ping <destination_ipv6> **source-ip** <source_ip>
ping <destination_ipv6> **tos** <0-255>
ping <destination_ipv6> **ttl** <1-255>

destination-ipv6	**IPv6 destination address.**
interface	Source interface to use for sending packets.
count	Number of ping packets to send (Default: 5).
do-not-fragment	Sets the 'do-not-fragment' (DF) bit in IP packet header.
interval	Interval time between the successive packets (Default: 1 second).
size	Size of the ping packet in bytes (Default: 60 bytes).
source-ipv6	IPv6 source address to use for the ping.
ttl	Time-to-Live value for the packet. Default value is 255.
tos	Type of Service (TOS) value to use in the packet. Applicable to IP header only. Default value 0

Example:

The following ping command sends ICMP echo requests (in the default instance) to a IPv6 destination address to verify reachability and measures round-trip latency.

The device successfully reached the IPv6 address '2001:db8:0:42::'. It sends 5 ICMPv6 echo requests and received 5 replies with 0 packet loss. The output shows the icmp_seq (sequence number of the request), ttl (time-to-live value of the returned packet) and time (round-trip latency in milliseconds) parameters. The statistics summary displays the number of packets sent/received and the packet-loss percentage.

```
admin@rtbrick: op> ping 2001:db8:0:42::
68 bytes from 2001:db8:0:42::: icmp_seq=1 ttl=64 time=.0503 ms
68 bytes from 2001:db8:0:42::: icmp_seq=2 ttl=64 time=.0321 ms
68 bytes from 2001:db8:0:42::: icmp_seq=3 ttl=64 time=.0314 ms
68 bytes from 2001:db8:0:42::: icmp_seq=4 ttl=64 time=.0325 ms
68 bytes from 2001:db8:0:42::: icmp_seq=5 ttl=64 time=.0354 ms
Statistics: 5 sent, 5 received, 0% packet loss
```

IPv6 Ping in a Specific Instance and AFI/SAFI

This functionality allows you to ping an IPv6 destination within a selected routing instance (VRF). You can specify the IPv6 address family to ensure the ping is executed using the correct protocol. It helps to validate IPv6 connectivity for services operating outside the default instance and to troubleshoot reachability in multi-VRF environments.

Syntax

ping <destination_ipv6> **afi ipv6**
ping <destination_ipv6> **count** <1-65535>
ping <destination_ipv6> **instance** <instance>
ping <destination_ipv6> **interval** <0.001-60.000>
ping <destination_ipv6> **safi** <unicast | multicast | labeled-unicast>
ping <destination_ipv6> **size** <8 - 32768>
ping <destination_ipv6> **source-interface** <source>
ping <destination_ipv6> **source-ip** <source_ip>
ping <destination_ipv6> **tos** <0-255>
ping <destination_ipv6> **ttl** <1-255>

destination-ipv6	**IPv6 destination address.**
instance-name	Name of the instance on which ping must be executed.

destination-ipv6	**IPv6 destination address.**
afi	IPv4 Address Family Identifier.
safi	Subsequent address family identifier. Supported options include unicast, multicast, and labeled-unicast. Default is unicast.
interface	Source interface to use for sending packets.
count	Number of ping packets to send (Default: 5).
do-not-fragment	Sets the do-not-fragment (DF) bit in IP packet header.
interval	Interval time between successive packets (Default: 1 second).
size	Size of the ping packet (Default: 60).
source-ipv6	IPv6 source address.
ttl	Time-to-live value to be used in the packet. Default value is 255.
tos	Type of Service (ToS) value to use in packet. Applicable to IP header only. Default value 0.



AFI and SAFI are optional attributes. If they are not explicitly specified, the system defaults to AFI 'IPv6' and SAFI 'unicast'.

Example:

In the following example, the command sends ICMP echo requests to the IPv6 destination address 2001:db8:0:42::. It verifies IPv6 connectivity over an MPLS labeled-unicast path within VRF named 'abc', and the output confirms successful, low-latency reachability with zero packet loss.

```
admin@rtbrick: op> ping 2001:db8:0:42:: instance abc afi ipv6 safi labeled-unicast
68 bytes from 2001:db8:0:42::: icmp_seq=1 ttl=64 time=.0503 ms
68 bytes from 2001:db8:0:42::: icmp_seq=2 ttl=64 time=.0321 ms
68 bytes from 2001:db8:0:42::: icmp_seq=3 ttl=64 time=.0314 ms
68 bytes from 2001:db8:0:42::: icmp_seq=4 ttl=64 time=.0325 ms
68 bytes from 2001:db8:0:42::: icmp_seq=5 ttl=64 time=.0354 ms
Statistics: 5 sent, 5 received, 0% packet loss
```

IP Traceroute

IP Traceroute in the Default Instance

This command traces the path taken by packets to a specified IP destination using the default routing instance.

Syntax:

```
traceroute <destination_ip> afi <ipv4 | ipv6>
traceroute <destination_ip> instance <instance>
traceroute <destination_ip> interval <0.001 - 60.000>
traceroute <destination_ip> maxhop <1 - 255>
traceroute <destination_ip> repeat <1 - 65535>
traceroute <destination_ip> safi <unicast | multicast | labeled-unicast>
traceroute <destination_ip> size <1 - 65535>
traceroute <destination_ip> source-interface <source>
traceroute <destination_ip> source-ip <source_ip>
```

destination-ip	**IPv4 destination address.**
interface	Name of the source interface.
repeat	Number of probe packets sent per hop (Default: 3).
safi	Subsequent address family identifier. Supported options include unicast, multicast, and labeled-unicast. Default is unicast.
interval	Time interval between probe packets (Default: 1 second).
size	Size of each traceroute packet in bytes (Default: 60).
source-ip	Source IP address .
maxhop	Maximum number of hops before the TTL expires (Default: 30).

Example:

This following traceroute command output shows a traceroute to destination 198.51.100.80 using the default settings (maximum 30 hops and 60-byte packets). The trace completes in two hops and displays the intermediate router at 198.51.100.90 followed by the destination, along with the round-trip time for three

probe packets at each hop.

```
admin@rtbrick: op> traceroute 198.51.100.80
traceroute to 198.51.100.80, 30 hops max, 60 byte packets
1    198.51.100.90    39.401 ms      19.919 ms      20.074 ms
2    198.51.100.80    55.544 ms      36.765 ms      45.989 ms
```

API To access the RESTCONF API that corresponds to this CLI, click here.

IP Traceroute in Specific Instance and AFI/SAFI

This command performs a traceroute to a specified IP destination using the routing table of a specific VRF.

Syntax:

traceroute <destination_ip> **afi** <ipv4 | ipv6>
traceroute <destination_ip> **instance** <instance>
traceroute <destination_ip> **interval** <0.001 - 60.000>
traceroute <destination_ip> **maxhop** <1 - 255>
traceroute <destination_ip> **repeat** <1 - 65535>
traceroute <destination_ip> **safi** <unicast | multicast | labeled-unicast>
traceroute <destination_ip> **size** <1 - 65535>
traceroute <destination_ip> **source-interface** <source>
traceroute <destination_ip> **source-ip** <source_ip>

destination-ip	**IPv4 destination address.**
instance-name	Name of the routing instance in which the traceroute is executed.
afi	Specifies the IP address family to use.
safi	Subsequent address family identifier. Supported options include unicast, multicast, and labeled-unicast. Default is unicast.
interface	Name of the source interface used to send traceroute probe packets.
repeat	Number of probe packets sent to each hop. (Default: 3).

destination-ip	IPv4 destination address.
interval	Time interval between packets in seconds. (Default: 1 second).
size	Size of the probe packet in bytes. (Default: 60 bytes).
source-ip	Source IP address for the traceroute probes.
maxhop	Maximum number of hops before the TTL expires. (Default: 30).

AFI and SAFI are optional attributes. If they are not explicitly specified, the system defaults to AFI 'IPv6' and SAFI 'unicast'.

In the following example, the traceroute command verifies IPv4 MPLS LSP connectivity (AFI IPv4, SAFI labeled-unicast) from the specified source interface/IP. The output shows label-switched forwarding and successful reachability of the destination 198.51.100.80 in the next hop. It indicates correct MPLS label distribution and forwarding along the path.

```
supervisor@rtbrick.net: cfg> traceroute 198.51.100.80 instance default afi ipv4
safi labeled-unicast source-interface
 ifl-0/0/0/1 source-ip 198.51.100.55
traceroute to 198.51.100.80 30 hops max, 60 byte packets
1    198.51.100.12    4.961 ms   .421 ms   .503 ms
     MPLS Label=20071  Exp=0  TTL=1  S=1
2    198.51.100.80    .995 ms   6.456 ms   .813 ms
```

For the MPLS transport, it displays the ingress labels in each hop.

IPv6 Traceroute

IPv6 Traceroute in the Default Instance

This command allows you to traceroute the hop-by-hop path to a given IP destination.

Syntax

traceroute <destination_ipv6> **afi** [**ipv4** | **ipv6**]
traceroute <destination_ipv6> **instance** <instance>
traceroute <destination_ipv6> **interval** [0.001 - 60.000]
traceroute <destination_ipv6> **maxhop** [1 - 255]

traceroute <destination_ipv6> **repeat** [1 - 65535]
traceroute <destination_ipv6> **safi** [**unicast** | **multicast** | **labeled-unicast**]
traceroute <destination_ipv6> **size** [1 - 65535]
traceroute <destination_ipv6> **source-interface** <source>
traceroute <destination_ipv6> **source-ip** <source_ip>

destination-ipv6	**IPv6 destination address.**
interface	Source interface name.
repeat	Number of packets sent per hop (Default: 3)
interval	Interval time between packets, in seconds (Default: 1)
size	Size of the traceroute packet in bytes (Default: 60)
source-ip	IPv6 source address.
maxhop	Maximum number of hops before the TTL expires (Default: 30).

The following example shows the IPv6 traceroute traces the hop-by-hop path to IPv6 destination (2001:db8:0:75::)> It shows the successful reachability within two hops and reporting round-trip latency for each hop using default traceroute parameters.

```
admin@rtbrick: op> traceroute 2001:db8:0:75::
traceroute to 2001:db8:0:75:: 30 hops max, 60 byte packets
1 2001:db8:0:90:: 21.247 ms 20.232 ms 20.052 ms
2 2001:db8:0:75:: 50.124 ms 59.822 ms 40.032 ms
```

IPv6 Traceroute in a Specific Instance and AFI/SAFI

This command allows you to traceroute to a particular IPv6 destination in a specific VRF.

Syntax

traceroute <destination_ipv6> **afi** [ipv4 | ipv6]
traceroute <destination_ipv6> **instance** <instance>
traceroute <destination_ipv6> **interval** [0.001 - 60.000]
traceroute <destination_ipv6> **maxhop** [1 - 255]
traceroute <destination_ipv6> **repeat** [1 - 65535]

traceroute <destination_ipv6> **safi** [unicast | multicast | labeled-unicast]
traceroute <destination_ipv6> **size** [1 - 65535]
traceroute <destination_ipv6> **source-interface** <source>
traceroute <destination_ipv6> **source-ip** <source_ip>

destination-ipv6	**IPv6 destination address.**
instance-name	Instance on which the traceroute command must be executed.
afi	Address Family Identifier (AFI).
safi	Subsequent address family identifier. Supported options include unicast, multicast, and labeled-unicast. Default is unicast.
interface	Name of the source interface.
repeat	Number of packets for each hop (Default, 3).
interval	The interval period between the packets (Default, 1 second).
size	Size of the traceroute packet (Default, 60).
source-ip	Source IPv6 address.
maxhop	Maximum number of hops before the TTL expires (Default, 30)



The AFI and SAFI attributes are optional. If not specified, the default AFI is 'IPv6' and the default SAFI 'unicast'.

The following example traceroute verifies IPv6 reachability (to 2001:db8:0:75::) using MPLS labeled-unicast in the default routing instance. The probe is sourced from ifl-0/0/0/1 (2001:db8:0:11::). The first hop is an MPLS hop (with the label 20072 and TTL=1). The destination is reached in the second hop.

```
supervisor@rtbrick.net: cfg> traceroute 2001:db8:0:75:: instance default afi ipv6
safi labeled-unicast source-interface
 ifl-0/0/0/1 source-ip 2001:db8:0:11::
traceroute to 2001:db8:0:75:: 30 hops max, 60 byte packets
1    2001:db8:0:90::    6.782 ms    .306 ms    6.380 ms
     MPLS Label=20072  Exp=0  TTL=1  S=1
2    2001:db8:0:75::    .434 ms    .657 ms    .844 ms
```



For MPLS transport paths, the output displays the ingress MPLS

label at each hop.

LSP Ping

The ping mpls command allows you to ping to an MPLS labelled switch path destination to see if a networked device is reachable.

Syntax:

ping mpls <destination_ip_fec> **fec-type** [**ldp** | **isis**]
ping mpls <destination_ip_fec> **instance** <instance>
ping mpls <destination_ip_fec> **maxhop** [1 - 64]
ping mpls <destination_ip_fec> **repeat** [1 - 10]
ping mpls <destination_ip_fec> **size** [1 - 8600]
ping mpls <destination_ip_fec> **source-ip** <source_ip>
ping mpls <destination_ip_fec> **wait-time** [1 - 60]

Attribute	Description
fec-type	Specifies the type of FEC to help the device identify the exact type. Default 'fec-type' is LDP.
instance	Specify the instance name.
wait-time	Specify the interval time (in seconds) between successive ping packets to send.
size	The size of the PAD TLV to be included in the MPLS Echo Request packet. (Default: 60 bytes).
repeat	Total number ping attempts the device sends to the destination. Default 3.
maxhop	Maximum number of hops the packet traverse (Default: 30).
source-ip	Specify the source IP address for the MPLS Echo Request.

Example: LSP ping for a prefix

In the following example, the MPLS ping verifies LDP-based MPLS connectivity to the FEC 62.154.10.70/32 by sending MPLS echo requests along the label-switched

path. All probes are successfully replied. The output shows 0 percent packet loss and stable round-trip times. The RTTs range from 7.61 ms to 47.30 ms confirms that the MPLS LSP to the destination is reachable and operational.

```
supervisor@rtr:op> ping mpls 62.154.10.70/32
Sending 5 MPLS Echos to ldp FEC 62.154.10.70/32
Success: Response from 217.239.37.58 : Egress for the FEC: seq = 1 rtt = 47.30 ms
Success: Response from 217.239.37.58 : Egress for the FEC: seq = 2 rtt = 13.96 ms
Success: Response from 217.239.37.58 : Egress for the FEC: seq = 3 rtt = 10.65 ms
Success: Response from 217.239.37.58 : Egress for the FEC: seq = 4 rtt = 7.61 ms
Success: Response from 217.239.37.58 : Egress for the FEC: seq = 5 rtt = 14.85 ms
---62.154.10.70/32 mpls ping statistics ---
5 sent, 5 received, 0 errors, 0% loss, time 5001.93 ms
rtt min/avg/max = 7.61/18.88/47.30 ms
```

Example: LSP ping for a FEC type

In the following example, the MPLS ping tests MPLS reachability to the FEC 62.154.20.70/32 using ISIS FEC. MPLS echo requests are sent along the IS-IS–signaled label-switched path. Four replies are received from 217.239.37.58. It is identified as the egress LSR for this FEC. While one probe does not receive a response, resulting in 20% packet loss. The measured RTTs range from 11.23 ms to 34.01 ms. It indicates that the MPLS LSP is reachable, though with an intermittent loss observed.

```
supervisor@rtr:op> ping mpls 62.154.20.70/32 fec-type isis
Sending 5 MPLS Echos to isis FEC 62.154.20.70/32
Success: Response from  217.239.37.58: Egress for the FEC: seq = 2 rtt = 27.97 ms
Success: Response from  217.239.37.58: Egress for the FEC: seq = 3 rtt = 16.76 ms
Success: Response from  217.239.37.58: Egress for the FEC: seq = 4 rtt = 34.01 ms
Success: Response from  217.239.37.58: Egress for the FEC: seq = 5 rtt = 11.23 ms
---62.154.10.70/32 mpls ping statistics ---
5 sent, 4 received, 0 errors, 20% packet loss, time 5001.93 ms
rtt min/avg/max = 11.23/19.88/34.01 ms
```

API To access the RESTCONF API that corresponds to this CLI, click here.

MPLS LSP Traceroute

The traceroute mpls command is used to trace the path of an MPLS Label Switched Path (LSP) hop by hop.

Syntax:

traceroute mpls <destination_ipv6_fec> **fec-type** [**ldp** | **isis**]

traceroute mpls <destination_ipv6_fec> **instance** <instance>
traceroute mpls <destination_ipv6_fec> **maxhop** [1 - 64]
traceroute mpls <destination_ipv6_fec> **repeat** [1 - 10]
traceroute mpls <destination_ipv6_fec> **size** [1 - 8600]
traceroute mpls <destination_ipv6_fec> **source-ip** <source_ip>
traceroute mpls <destination_ipv6_fec> **wait-time** [1 - 60]

Attribute	Description
-	Without any option, the command traceroute for the specified prefix.
fec-type [ldp | isis]	Specifies the type of FEC to help the device identify the exact type. Default 'fec-type' is LDP.
instance	Specify the instance name. Instance in which the prefix needs to be looked up (Default: 'default')
maxhop	Maximum number of hops (Default: 30).
size	The size of the PAD TLV to be included in the MPLS Echo Request packet. (Default: 60 bytes).
wait-time	Specify the wait time (in seconds) to receive the response. (1-60).
repeat	Number of packets to be repeated with same TTL. Default 3.
source-ip	Source IP address.

Example: LSP traceroute for a FEC type

The following example shows the MPLS traceroute traces the LDP-signaled label-switched path to the FEC 192.168.0.40/32 by sending MPLS echo requests with increasing TTL values. The output shows three MPLS hops in the LSP. At each transit hop, labels are swapped. It confirms correct LDP label forwarding. The final hop (34.0.0.4) is identified as the egress LSR for the FEC. All probes are successfully received (0% loss), with measured RTTs at each hop.

```
Sending MPLS echoes to ldp FEC 192.168.0.40/32 for traceroute
TTL  Address       Label    Protocol  Down Addr               Down Label  Status
RTT
  1  12.0.0.2      519942   ldp       23.0.0.3                519938      Label
switched at stack-depth 1    45.15ms, 3.20ms, 3.21ms
  2  23.0.0.3      519938   ldp       34.0.0.4                3           Label
```

```
switched at stack-depth 1    3.18ms, 4.25ms, 2.17ms
  3  34.0.0.4      3        ldp       -                        -           Egress
for the FEC                 37.18ms, 4.23ms, 3.22ms
--- 192.168.0.40/32 mpls traceroute statistics ---
9 sent, 9 received, 0 errors, 0.00% loss, time 17617.15 ms
```

API To access the RESTCONF API that corresponds to this CLI, click here.

Show Commands

Show OAM MPLS

The command displays LSP ping command details.

Syntax:

show oam mpls <option>

Option	Description
statistics	Displays MPLS LSP ping statistics.

Example: OAM MPLS LSP Ping statistics

The show oam mpls statistics output indicates that no MPLS OAM activity has occurred on the device. No MPLS echo requests or replies have been sent or received. All transmit and receive error counters remain at zero. It indicates that MPLS OAM is currently idle, with no tests.

```
supervisor@Brtbrick.net: cfg> show oam mpls statistics
Sent Statistics:
MPLS echo request sent          : 0
MPLS echo reply sent            : 0
Sent error                      : 0
Sent error - No table           : 0
Sent error - No FEC             : 0
Sent error - No Adjacency       : 0
Sent error - No MPLS Adjacency  : 0
Sent error - No interface       : 0
Sent error - Encode failure     : 0

Received Statistics:
MPLS echo received              : 0
MPLS echo request received      : 0
MPLS echo reply received        : 0
Receive error - L3 decode       : 0
Receive error - header decode   : 0
```

```
Receive error - TLV decode      : 0
Receive error - FEV TLV decode  : 0
Receive error - unsupported FEV : 0
Receive error - no session      : 0
```

Show OAM IP Statistics

The 'show oam ip statistics' command displays information about sent and received OAM IP packet counters.

Syntax:

show oam ip statistics

The following example show command output displays the sent and received statistics for an echo request message.

```
supervisor@rtbrick: cfg> show oam ip statistics
Sent Statistics:
Echo request sent                          : 0
Sent error                                 : 0
Sent error - no table                      : 0
Sent error - no route                      : 2
Sent error - no adjacency                  : 0
Sent error - no interface                  : 0
Sent error - encode failure                : 0

Received Statistics:
Echo reply received                        : 0
Echo reply - TTL expired                   : 0
Echo reply - destination unreachable       : 0
Receive error - L3 decode                  : 0
Receive error - no session                 : 0
```

Clear Commands

clear oam ip statistics

The 'clear oam ip statistics' command is used to reset the OAM IP statistics counters.

Syntax:

clear oam ip statistics

Example for 'clear oam ip statistics' command:

```
supervisor@rtbrick: cfg> clear oam ip statistics
Success: IP oam statistics cleared
```

8. Multicast

8.1. IGMP

8.1.1. IGMP Overview

Internet Group Management (IGMP) protocol allows a host to advertise its multicast group membership to neighboring switches and routers. IGMP is a standard protocol used by the TCP/IP protocol suite to achieve dynamic multicasting.

There are two components in the IGMP solution:

- IGMPv2/v3 Client: It sends Join or Leave messages to a multicast group. Typical example of a client is a SET-TOP box. The IGMP client can respond to any IGMP general queries or group-specific queries that are received.
- Multicast Router: The recipient of IGMP Join/Leave message. After receiving the message, it determines whether the corresponding message needs to be processed or not. After processing the IGMP messages, it sends this information to its multicast upstream router. Along with this, it can program certain entries in its routers which results in forwarding specific multicast packets on that interface.

IGMPv3 Lite

IGMP version 3 adds support for "source filtering", that is, the ability for a system to report interest in receiving packets **only** from specific source addresses, or from **all but** specific source addresses, sent to a particular multicast address. That information may be used by multicast routing protocols to avoid delivering multicast packets from specific sources to networks where there are no interested receivers.

The RtBrick IGMP v3lite solution adds support for source filtering. Source filtering enables a multicast receiver host to signal from which groups it wants to receive multicast traffic, and from which sources this traffic is expected. That information may be used by multicast routing protocols to avoid delivering multicast packets from specific sources to networks where there are no interested receivers.

IGMP Version 3 will help conserve bandwidth by allowing a host to select the

specific sources from which it wants to receive traffic. Also, multicast routing protocols will be able to make use of this information to conserve bandwidth when constructing the branches of their multicast delivery trees.

Static Joins

After an interface on a multicast device is configured to statically join an IGMP group, the multicast device considers that the interface has static multicast group members and sends multicast packets to this interface, regardless of whether hosts connected to this interface request the multicast packets.

SSM Mapping

SSM mapping takes IGMPv2 reports and converts them to IGMPv3. In case of legacy devices, there could be a possibility that BNG might receive IGMPv2 membership reports. If BNG receives an IGMPv2 membership for a specific group G1, BNG uses the SSM mapping configuration to determine one or more Source (S) addresses for a given group. This SSM mappings are translated to the IGMPv3 joins like IGMPV3 JOIN INCLUDE (G, [S1, G1], [S2, G1] and so on) and BNG continues to process as if it has received from the subscriber.

Supported Platforms

Not all features are necessarily supported on each hardware platform. Refer to the *Platform Guide* for the features and the sub-features that are or are not supported by each platform.

8.1.2. IGMP Configuration

Configuration Hierarchy

The diagram illustrates the IGMP configuration hierarchy.

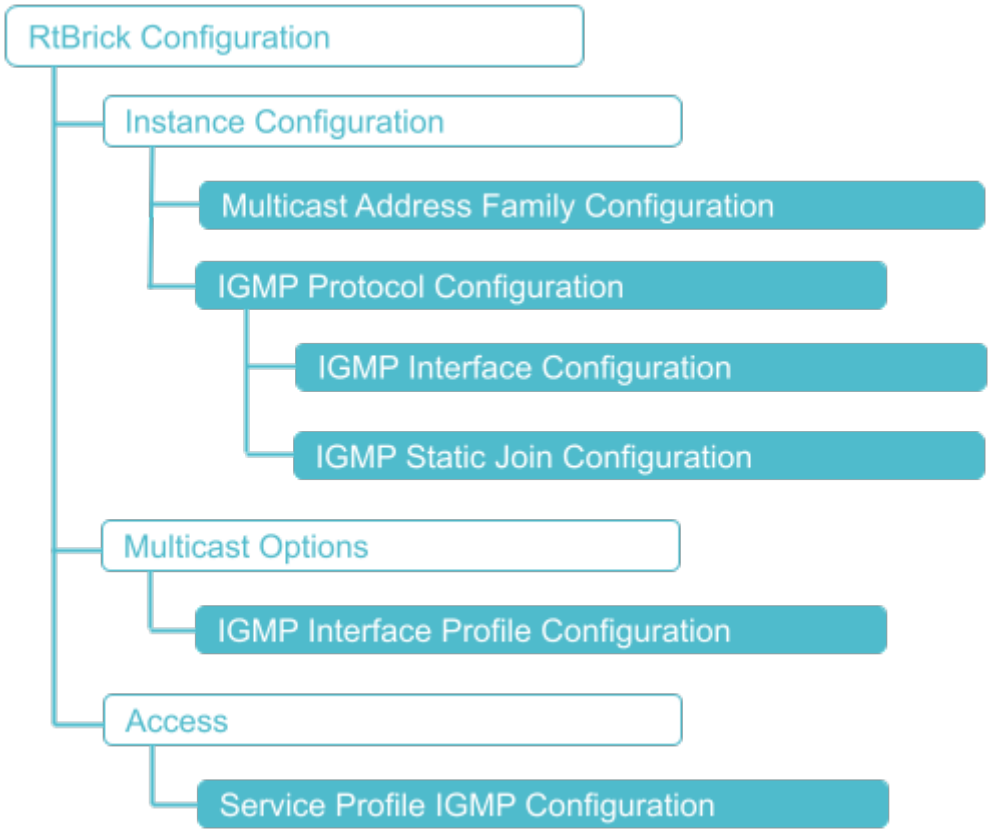


Figure 146. IGMP Configuration Hierarchy

Configuration Syntax and Commands

The following sections describe the interface configuration syntax and commands.

Multicast Address Family Configuration

You can enable the multicast IPv4 address family under the IGMP instance using the following command:

Syntax:

```
set instance <instance> address-family <attribute> <value>
```

Attribute	Description
<instance>	Specifies the name of the network instance
<afi>	Address family identifier (AFI). Supported value: ipv4

Attribute	Description
<safi>	Subsequent address family identifier (SAFI), that is, multicast.

Example: Multicast Address Family Configuration

```
{
    "rtbrick-config:address-family": [
      {
        "afi": "ipv4",
        "safi": "multicast"
      }
    ]
  }
```

IGMP Protocol Configuration

To configure an IGMP on an instance, the same instance should be enabled globally with AFI IPv4 and SAFI as both unicast and multicast.

Syntax:

set instance <instance> **protocol igmp** <attribute> <values>



If no instance is specified, IGMP will be enabled on the default instance.

Options	Description
<instance>	Name of the IGMP instance.
interfaces <...>	IGMP interface configuration. Refer to the IGMP Interface Configuration section for the IGMP interface configuration.
robustness-variable <variable-value>	The robustness value is used by IGMP to determine the number of times to send messages. Default value: 3. Range: 0-255.

Options	Description
source-address <source-address>	Source address of the IGMP query at the instance-level. NOTE: IF subscriber IFL is configured with the source address, then takes priority; otherwise, the the instance-level source address will be used. If source address is not configured, 0.0.0.0 will be the default address.
static-group <...>	Static multicast route configuration. Refer to the IGMP Static Join Configuration section for details on the IGMP static join configuration.

Example: IGMP Configuration

```
{
    "rtbrick-config:igmp": {
      "robustness-variable": 5,
      "source-address": "198.51.100.177"
    }
  }
```

To access the RESTCONF API that corresponds to this CLI, click here.

IGMP Interface Configuration

When you start IGMP on an interface, it operates with the default settings.

Syntax:

set instance <instance> **protocol igmp interfaces interface** <interface-name> <attribute> <value>

Attribute	Description
<instance>	Name of the instance
<interface-name>	Name of the IP multicast interface
max-groups <count>	Specifies the maximum count of multicast group memberships

Attribute	Description
version <version>	Specifies the IGMP version, that is, IGMPv2 or IGMPv3
interface-profile <profile>	Name of the interface configuration profile

Example: IGMP Interface Configuration

```
{
    "rtbrick-config:interface": [
      {
        "interface-name": "ifl-0/0/0/1",
        "version": "IGMPv3",
        "max-groups": 30,
        "interface-profile": "profile1"
      }
    ]
  }
```

To access the RESTCONF API that corresponds to this CLI, click here.

IGMP Static Join Configuration

Syntax:

set instance <instance> **protocol igmp static-group** <attribute> <value>

Command Parameters

<instance>	Specifies the instance name
<group-address>	Specifies the multicast address
<outgoing-interface>	Name of the outbound interface. The null0 is a discard or sink interface for IGMP static join configuration. If IGMP Static Join is configured with the Null0 outgoing interface, then it is mandatory to configure the null0 IGMP interface.

Example: IGMP Static Join Configuration

```
{
    "rtbrick-config:static-group": [
      {
        "group-address": "198.51.100.200",
        "source-address": "198.51.100.1",
        "outgoing-interface": "null0"
```

```
      }
    ]
  }
```

To access the RESTCONF API that corresponds to this CLI, click here.

IGMP Interface Profile Configuration

Syntax:

set multicast-options igmp interface-profile <attribute> <value>

Attribute	Description
filter-policy <filter-policy>	Specifies the filter policy. The policy should be defined under policy statement.
immediate-leave <enable | disable>	Enable or disable the immediate leave option. The immediate-leave attribute removes group membership immediately upon receiving a group leave membership report. If enabled, IGMP perform an immediate leave upon receiving an IGMP group leave message. If the router is IGMP-enabled, it sends an IGMP last member query with a last member query response time. However, the router does not wait for the response time before it prunes off the group querier-timeout-interval IGMP other querier timeout. Default: 425s
query-interval <query-interval>	IGMP query interval in seconds. The query interval ranges from 1 to 1024 seconds. The default value is 125 seconds.
query-max-response-time <query-max-response-time>	Maximum query response interval in seconds. The maximum query response interval ranges from 1 to 1024 seconds. The default value is 100 seconds.
ssm-map-policy <ssm-map-policy>	IGMP SSM policy name. The policy for (**,G) mapping to (S,G**)
start-query-count <start-query-count>	Specifies the number of queries sent out on startup, separated by the Start Query Interval. The start query count ranges from 1 to 1024. The default value is 3.

Attribute	Description
start-query-interval <start-query-interval>	Specifies the start query interval. The start-query-interval ranges from 1 to 1024 seconds. The default value is 31 seconds (query-interval/4).

Example: IGMP Interface Profile Configuration

```
{
    "rtbrick-config:interface-profile": [
      {
        "profile-name": "profile1",
        "immediate-leave": "enable",
        "query-interval": 30,
        "query-max-response-time": 10,
        "start-query-count": 10,
        "start-query-interval": 10,
        "filter-policy": "filter_policy",
        "ssm-map-policy": "ssm_policy"
      }
    ]
  }
```

Service Profile IGMP Configuration

Syntax:

set access service-profile <profile-name> **igmp** <attribute> <value>

Attribute	Description
<profile-name>	Name of the service profile
enable <true|false>	Enable IGMP service
max-members <max-members>	Maximum IGMP membership per subscriber
profile <profile>	IGMP profile
version [IGMPv1/IGMPv2/IGMPv3]	IGMP version. The default IGMP version is IGMPv3.

Example: Service Profile IGMP Configuration

```
{
    "rtbrick-config:service-profile": [
```

```
      {
        "profile-name": "service-profile1",
        "igmp": {
          "enable": "true",
          "profile": "INTERFACE_PROFILE_1",
          "version": "IGMPv3",
          "max-members": 10
        }
      }
    ]
  }
```

IGMP Configuration Example

```
{
  "ietf-restconf:data": {
    "rtbrick-config:instance": [
      {
        "name": "default",
        "protocol": {
          "igmp": {
            "robustness-variable": 5,
            "source-address": "198.51.100.91"
          }
        }
      }
    ],
    "rtbrick-config:multicast-options": {
      "igmp": {
        "interface-profile": [
          {
            "profile-name": "INTERFACE_PROFILE_1",
            "query-interval": 10,
            "filter-policy": "FILTER_POLICY_1"
          },
          {
            "profile-name": "INTERFACE_PROFILE_2",
            "query-interval": 20,
            "ssm-map-policy": "SSM_POLICY_1"
          }
        ]
      }
    },
    "rtbrick-config:policy": {
      "statement": [
        {
          "name": "FILTER_POLICY_1",
          "ordinal": [
            {
              "ordinal": 1,
              "match": {
                "rule": [
                  {
                    "rule": 1,
                    "type": "ipv4-mcast-group",
                    "value-type": "discrete",
                    "match-type": "or-longer",
                    "value": "198.51.100.20/24"
```

```
                }
              ]
            },
            "action": {
              "rule": [
                {
                  "rule": 1,
                  "operation": "return-deny"
                }
              ]
            }
          },
          {
            "ordinal": 2,
            "action": {
              "rule": [
                {
                  "rule": 1,
                  "operation": "return-permit"
                }
              ]
            }
          }
        ]
      },
      {
        "name": "SSM_POLICY_1",
        "ordinal": [
          {
            "ordinal": 1,
            "match": {
              "rule": [
                {
                  "rule": 1,
                  "type": "ipv4-mcast-group",
                  "value-type": "discrete",
                  "match-type": "or-longer",
                  "value": "198.51.100.10/24"
                }
              ]
            },
            "action": {
              "rule": [
                {
                  "rule": 1,
                  "type": "ipv4-mcast-source",
                  "operation": "overwrite",
                  "value": "198.51.100.11/24"
                }
              ]
            }
          }
        ]
      }
    ]
  },
  "rtbrick-config:access": {
    "interface": {
      "double-tagged": [
        {
          "interface-name": "ifp-0/0/1",
```

```
            "outer-vlan-min": 1,
            "outer-vlan-max": 4049,
            "inner-vlan-min": 1,
            "inner-vlan-max": 4049,
            "access-type": "PPPoE",
            "access-profile-name": "access-profile1",
            "service-profile-name": "service-profile1",
            "aaa-profile-name": "aaa-profile1"
          }
        ]
      },
      "service-profile": [
        {
          "profile-name": "service-profile1",
          "igmp": {
            "enable": "true",
            "profile": "INTERFACE_PROFILE_1",
            "version": "IGMPv3",
            "max-members": 10
          }
        }
      ]
    }
  }
}
```

8.1.3. IGMP Operational Commands

IGMP Show Commands

Syntax:

show igmp <option>

Option	Description
group	IGMP group summary information
group <group>	IGMP group detailed information
group instance <name>	IGMP group summary information in a specific instance
group outgoing-interface <interface_name>	IGMP group detailed information over a specific interface
interface	IGMP logical-interface summary information
interface instance <name>	IGMP interface summary information on specific instance

Option	Description
interface <interface_name>	IGMP interface detailed information

Example 1: Display IGMP interface details for all instances

```
supervisor@rtbrick>LEAF01: op> show igmp interface
Interface                      Primary Address   State          Querier Address
Instance          Uptime
null0                          n/a               n/a            n/a
vpn1            n/a
ppp-0/0/3/72339069014638597   198.51.100.100     Querier        198.51.100.133
vpn1    03h:37m:31s
```

Example 2: Display the interface summary for a specific instance

```
supervisor@rtbrick>LEAF01: op> show igmp interface instance vpn1
Interface                      Primary Address   State          Querier Address
Instance          Uptime
null0                          n/a               n/a            n/a
vpn1            n/a
ppp-0/0/3/72339069014638597   198.51.100.100     Querier       198.51.100.133
vpn1            03h:37m:39s
```

Example 3: Display IGMP group summary on all instances

```
supervisor@rtbrick>LEAF01: op> show igmp group
Source Address      Group Address       Interface                      Instance
Uptime         Expires     Version
198.51.100.79      198.51.100.233       null0                            vpn1
03h:42m:33s    n/a         IGMP
198.51.100.43   198.51.100.222         null0                            vpn1
03h:42m:33s    n/a         IGMP
198.51.100.51     198.51.100.71         ppp-0/0/3/72339069014638597     vpn1
00h:32m:58s    1m 43s      IGMPv3
198.51.100.51      198.51.100.72        ppp-0/0/3/72339069014638597     vpn1
00h:33m:03s    1m 48s      IGMPv3
198.51.100.53         198.51.100.73     ppp-0/0/3/72339069014638597     vpn1
00h:35m:26s    3m 36s      IGMPv3
198.51.100.54         198.51.100.74     ppp-0/0/3/72339069014638597     vpn1
00h:35m:26s    3m 35s      IGMPv3
198.51.100.56         198.51.100.115    ppp-0/0/3/72339069014638597     vpn1
03h:38m:16s    3m 33s      IGMPv3
198.51.100.57         198.51.100.117    ppp-0/0/3/72339069014638597     vpn1
03h:38m:16s    3m 29s      IGMPv3
198.51.100.58         198.51.100.18     ppp-0/0/3/72339069014638597     vpn1
03h:38m:16s    3m 42s      IGMPv3
198.51.100.59         198.51.100.19     ppp-0/0/3/72339069014638597     vpn1
03h:38m:16s    3m 35s      IGMPv3
198.51.100.90        198.51.100.64      ppp-0/0/3/72339069014638597     vpn1
03h:38m:16s    3m 40s      IGMPv3
198.51.100.225       198.51.100.68      ppp-0/0/3/72339069014638597     vpn1
```

```
00h:35m:26s    3m 40s      IGMPv3
```

Example 4: Display the group summary on specific instance

```
supervisor@rtbrick>LEAF01: op> show igmp group instance vpn1
Source Address      Group Address       Interface                      Instance
Uptime         Expires     Version
198.51.100.79     198.51.100.233        null0                            vpn1
03h:42m:37s    n/a         IGMP
198.51.100.43   198.51.100.233          null0                            vpn1
03h:42m:37s    n/a         IGMP
198.51.100.51       198.51.100.71       ppp-0/0/3/72339069014638597     vpn1
00h:33m:02s    1m 40s      IGMPv3
198.51.100.51       198.51.100.72       ppp-0/0/3/72339069014638597     vpn1
00h:33m:07s    1m 45s      IGMPv3
198.51.100.53       198.51.100.73       ppp-0/0/3/72339069014638597     vpn1
00h:35m:30s    3m 41s      IGMPv3
198.51.100.54       198.51.100.74       ppp-0/0/3/72339069014638597     vpn1
00h:35m:30s    3m 43s      IGMPv3
198.51.100.56       198.51.100.115      ppp-0/0/3/72339069014638597     vpn1
03h:38m:20s    3m 43s      IGMPv3
198.51.100.57       198.51.100.117      ppp-0/0/3/72339069014638597     vpn1
03h:38m:20s    3m 42s      IGMPv3
198.51.100.58        198.51.100.18      ppp-0/0/3/72339069014638597     vpn1
03h:38m:20s    3m 39s      IGMPv3
198.51.100.59         198.51.100.19     ppp-0/0/3/72339069014638597     vpn1
03h:38m:20s    3m 42s      IGMPv3
198.51.100.90        198.51.100.64      ppp-0/0/3/72339069014638597     vpn1
03h:38m:20s    3m 37s      IGMPv3
198.51.100.225       198.51.100.68      ppp-0/0/3/72339069014638597     vpn1
00h:35m:30s    3m 36s      IGMPv3
```

Example 5: Display detailed group information for specific group and source on all instances

```
supervisor@rtbrick>LEAF01: op> show igmp group 198.51.100.233 198.51.100.79
(198.51.100.79, 198.51.100.233)
  Outgoing interface      : null0
  Instance                : vpn1
  Source                  : Static
  State                   : No Members Present
  Version                 : IGMP
  Uptime                  : 03h:42m:54s
  Expires                 : n/a
  Membership interval     : n/a
  Last reporter           : n/a
  Last member query count : n/a
  Last member interval    : n/a
  Retransmit time         : n/a
  Max response time       : n/a
```

Example 6: Display detailed group information for specific group and source on all instances

```
supervisor@rtbrick>LEAF01: op> show igmp group outgoing-interface ppp-
0/0/3/72339069014638597
(198.51.100.51, 198.51.100.71)
  Outgoing interface      : ppp-0/0/3/72339069014638597
  Instance                : vpn1
  Source                  : Dynamic
  State                   : Members Present
  Version                 : IGMPv3
  Uptime                  : 00h:33m:44s
  Expires                 : 1m 43s
  Membership interval     : 110s
  Last reporter           : 198.51.100.100
  Last member query count : 3
  Last member interval    : 1s
  Retransmit time         : 1s
  Max response time       : 0s
(198.51.100.51, 198.51.100.72)
  Outgoing interface      : ppp-0/0/3/72339069014638597
  Instance                : vpn1
  Source                  : Dynamic
  State                   : Members Present
  Version                 : IGMPv3
  Uptime                  : 00h:33m:49s
  Expires                 : 1m 48s
  Membership interval     : 110s
  Last reporter           : 198.51.100.100
  Last member query count : 3
  Last member interval    : 1s
  Retransmit time         : 1s
  Max response time       : 0s
(198.51.100.53, 198.51.100.73)
  Outgoing interface      : ppp-0/0/3/72339069014638597
  Instance                : vpn1
  Source                  : Dynamic
  State                   : Members Present
  Version                 : IGMPv3
  Uptime                  : 00h:36m:12s
  Expires                 : 3m 37s
  Membership interval     : 225s
  Last reporter           : 198.51.100.100
  Last member query count : 3
  Last member interval    : 1s
  Retransmit time         : 1s
  Max response time       : 0s
(198.51.100.54, 198.51.100.74)
  Outgoing interface      : ppp-0/0/3/72339069014638597
  Instance                : vpn1
  Source                  : Dynamic
  State                   : Members Present
  Version                 : IGMPv3
  Uptime                  : 00h:36m:12s
  Expires                 : 3m 41s
  Membership interval     : 225s
  Last reporter           : 198.51.100.100
  Last member query count : 3
  Last member interval    : 1s
  Retransmit time         : 1s
  Max response time       : 0s
(198.51.100.56, 198.51.100.115)
  Outgoing interface      : ppp-0/0/3/72339069014638597
```

```
  Instance                : vpn1
  Source                  : Dynamic
  State                   : Members Present
  Version                 : IGMPv3
  Uptime                  : 03h:39m:02s
  Expires                 : 3m 38s
  Membership interval     : 225s
  Last reporter           : 198.51.100.100
  Last member query count : 3
  Last member interval    : 1s
  Retransmit time         : 1s
  Max response time       : 0s
```

Example 7: Display detailed group information for specific group and source on selected instance

```
supervisor@rtbrick>LEAF01: op> show igmp group instance vpn1 198.51.100.117
198.51.100.57
(198.51.100.57, 198.51.100.117)
  Outgoing interface      : ppp-0/0/3/72339069014638597
  Instance                : vpn1
  Source                  : Dynamic
  State                   : Members Present
  Version                 : IGMPv3
  Uptime                  : 03h:39m:31s
  Expires                 : 3m 34s
  Membership interval     : 225s
  Last reporter           : 198.51.100.100
  Last member query count : 3
  Last member interval    : 1s
  Retransmit time         : 1s
  Max response time       : 0s
supervisor@rtbrick>LEAF01: op>
```

IGMP Clear Commands

IGMP Interface

Syntax:

clear igmp interface <attribute> <value>

Option	Description
<interface_name>	Clears the specified IGMP interface
instance <instance> statistics	Clears the IGMP interface statistics for the specified instance.

Example: Clear interface IGMP statistics

```
supervisor@rtbrick>LEAF01: op> clear igmp interface instance default statistics
Interface IGMP statistics were successfully cleared
supervisor@rtbrick>LEAF01: op>
```

IGMP Group

Syntax:

clear igmp group <attribute> <value>

Option	Description
all	Clear all IGMP groups present on all instances
instance <instance>	Clear all IGMP groups present on specific instance
interface <interface_name>	Clear all IGMP groups present on specific interface

Example: Clear all IGMP groups present on all instances

```
supervisor@rtbrick>LEAF01: op> clear igmp group all
IGMP groups were successfully cleared
supervisor@rtbrick>LEAF01: op>
```

8.2. PIM

8.2.1. PIM Overview

PIM SSM builds shortest-path trees (SPTs) rooted at the source immediately because in SSM, the router closest to the interested receiver host is informed of the unicast IP address of the source for the multicast traffic. That is, PIM SSM bypasses the RP connection stage through shared distribution trees, as in PIM sparse mode, and goes directly to the source-based distribution tree.

Internet Protocol Television (IPTV) is a service where digital TV signal data is delivered by using Internet protocol (IP). IPTV service networks typically use PIM-SSM as the multicast routing protocol which has the following characteristics:

- Source specific host membership report for a particular multicast group. IGMPv3 allows a host to describe specific sources from which it would like to receive data.
- PIM shortest path forwarding. Source-specific host report for a particular multicast group and initiating PIM (S,G) joins directly and immediately as result.
- No shared tree forwarding. In order to achieve global effectiveness of SSM, all networks must agree to restrict data forwarding to source trees for some recognized group range. The address range 232.0.0.0/8 has been allocated by IANA for use by source specific multicast (SSM).

Supported Platforms

Not all features are necessarily supported on each hardware platform. Refer to the *Platform Guide* for the features and the sub-features that are or are not supported by each platform.

8.2.2. PIM Configuration

Configuration Hierarchy

The diagram illustrates the PIM configuration hierarchy.

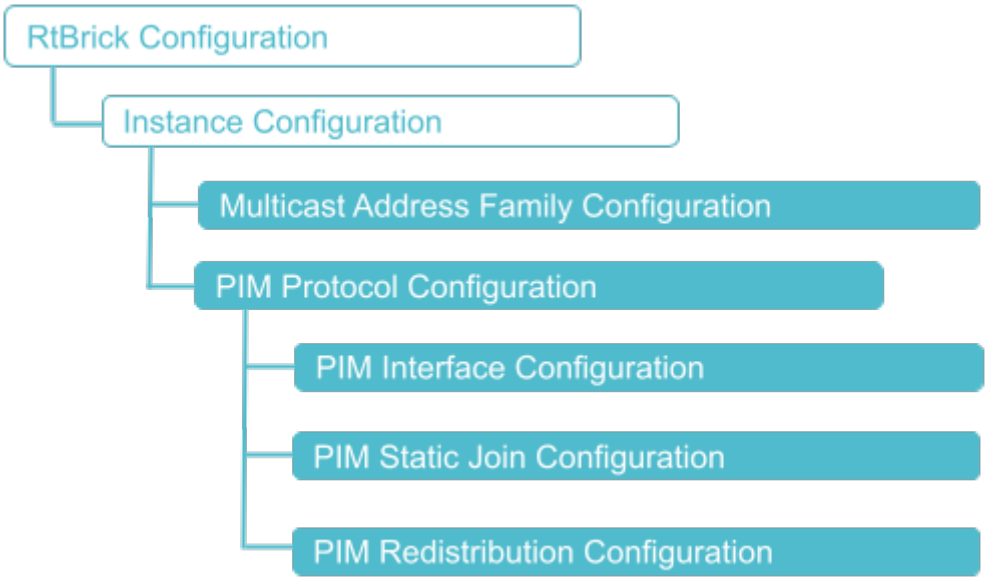


Figure 147. PIM Configuration Hierarchy

Configuration Syntax and Commands

The following sections describe the interface configuration syntax and commands.

Multicast Address Family Configuration

You can enable the multicast IPv4 address family under the PIM instance using the following command:

Syntax:

set instance <instance> **address-family** <attribute> <value>

Attribute	Description
<instance>	Specifies the name of the network instance
<afi>	Address family identifier (AFI). Supported values: ipv4
<safi>	Subsequent address family identifier (SAFI), that is, multicast.

Example: Multicast Address Family Configuration

```
{
    "rtbrick-config:address-family": [
      {
        "afi": "ipv4",
        "safi": "multicast"
      }
    ]
  }
```

PIM Protocol Configuration

Syntax:

set instance <instance> **protocol pim** <attribute> <value>



If no instance is specified, PIM will be enabled on the default instance. RBFS supports only IPV4 address family.

Attribute	Description
<instance>	Specifies the name of the instance
afi <afi>	Address family identifier (AFI). Supported: ipv4
join-prune-interval <join-prune-interval>	PIM join & prune interval. The interval ranges from 10 to 600 seconds. By default, join & prune interval is 60 seconds and hold-down timer is 210 seconds.
sparse-mode interface <...>	Reference to an entry in the global interface list. Refer to the PIM Interface Configuration section for details on the PIM interface configuration.
sparse-mode static-join <...>	A static pim join, (*\,G) or (S,G). Refer to the PIM Static Join Configuration section for details on the PIM static join configuration.
sparse-mode redistribute <...>	Redistribution-related configuration. Refer to the PIM Redistribution Configuration section for details on the PIM redistribution configuration.

API To access the RESTCONF API that corresponds to this CLI, click here.

PIM Interface Configuration

Syntax:

set instance <instance> **protocol pim sparse-mode interface** <attribute> <value>

Attribute	Description
<instance>	Specifies the name of the instance
<interface-name>	Reference to an entry in the global interface list
afi <afi>	Address family identifier (AFI). Supported: ipv4
dr-priority <dr-priority>	Specifies the Specifies the designated router (DR) priority value.
hello-interval <hello-interval>	Specifies the hello timer in seconds. The hello timer ranges from 1 to 3600 seconds. Default: 30 seconds.

Attribute	Description
override-interval <override-interval>	Specifies the override interval in milliseconds. Default: 2000 milliseconds.
propagation-delay <propagation-delay>	Specifies the propagation delay in milliseconds. Default: 500 milliseconds.

Example: PIM Interface Configuration

```
{
    "rtbrick-config:interface": [
      {
        "interface-name": "ifl-0/0/0/1",
        "hello-interval": 100,
        "dr-priority": 101
      },
      {
        "interface-name": "ifl-0/0/1/2"
      },
      {
        "interface-name": "ifl-0/0/3/3",
        "propagation-delay": 103,
        "override-interval": 1000
      }
    ]
  }
```

API To access the RESTCONF API that corresponds to this CLI, click here.

PIM Static Join Configuration

Syntax:

set instance <instance> **protocol pim sparse-mode static-join** <attribute> <value>

Attribute	Description
<instance>	Specifies the name of the instance
<interface-name>	Reference to an entry in the global interface list
<outgoing-interface>	Multicast outbound interface name
<group-address>	Multicast group IP address
<source-address>	Multicast source IP address

Example: PIM Static Join Configuration

```
{
    "rtbrick-config:static-join": [
      {
        "outgoing-interface": "ifl-0/0/0/1",
        "group-address": "198.51.100.12",
        "source-address": "198.51.100.120"
      }
    ]
  }
```

To access the RESTCONF API that corresponds to this CLI, click here.

PIM Redistribution Configuration

Syntax:

set instance <instance> **protocol pim sparse-mode redistribute** <attribute> <value>

Command Parameters

<instance>	Specifies the name of the instance.
<afi>	Specifies the address family identifier. Supported value: ipv4.
<safi>	Specifies the subsequent address family identifier. Supported value: multicast.
<source>	Source protocol from which routes are being redistributed such as BGP or static.

Example: PIM Redistribution Configuration

```
{
    "rtbrick-config:redistribute": [
      {
        "afi": "ipv4",
        "safi": "multicast",
        "source": "bgp"
      }
    ]
  }
```

To access the RESTCONF API that corresponds to this CLI, click here.

PIM Configuration Example

```
{
    "rtbrick-config:pim": {
      "sparse-mode": {
        "interface": [
          {
            "interface-name": "ifp-0/0/1"
          }
        ],
        "redistribute": [
          {
            "afi": "ipv4",
            "safi": "multicast",
            "source": "bgp"
          }
        ],
        "static-join": [
          {
            "outgoing-interface": "null0",
            "group-address": "198.51.100.110",
            "source-address": "198.18.73.250"
          },
          {
            "outgoing-interface": "null0",
            "group-address": "198.51.100.111",
            "source-address": "198.18.73.250"
          },
          {
            "outgoing-interface": "null0",
            "group-address": "198.51.100.112",
            "source-address": "198.18.73.250"
          },
          {
            "outgoing-interface": "null0",
            "group-address": "198.51.100.113",
            "source-address": "198.18.73.250"
          }
        ]
      }
    }
  }
```

8.2.3. PIM Operational Commands

PIM Show Commands

PIM Interface

Syntax:

show pim interface <option>

Option	Description
-	Without any option, the commands displays the information for all interfaces.
<interface_name>	Displays the PIM interface detail for the default instance
instance <instance_name>	Displays interface summary on specific instance

Example 1: Summary of PIM logical interface for all instances.

```
supervisor@rtbrick: op> show pim interface
Interface      Instance     IP Address        State      DR                Generator ID
ifl-1/7/1/1    default      198.51.100.247    Non-DR     198.51.100.42     1896236448
null0          default      n/a               n/a        n/a               n/a
ifl-0/0/3/3    vpn1         198.51.100.25     Non-DR     198.51.100.33     2123016228
```

Example 2: Summary of interfaces for the specified instance.

```
supervisor@rtbrick: op> show pim interface instance vpn1
Interface       Instance     IP Address        State      DR                Generator ID
ifl-0/0/3/3     vpn1         198.51.100.25     Non-DR     198.51.100.33     2123016228
```

Example 3: Detailed view of the specified PIM interface.

```
supervisor@rtbrick: op> show pim interface ifl-0/0/3/3
Interface: ifl-0/0/3/3
  Instance                  : vpn1
  State                     : Non-DR
  Primary address           : 198.51.100.25
  Generation ID             : 2123016228
  Timer values
    Hello interval          : 35s
    Join/Prune interval     : 35s
    Hold interval           : 105s
    Override interval       : 2000ms
    Prune delay interval    : 500ms
  DR election
    DR address              : 198.51.100.33
    DR priority             : 1
    DR election count       : 251
  Negotiated
    DR priority used        : True
    Lan delay used          : False
    Lan prune interval      : 0
    Lan override  used      : False
```

```
    Lan override interval  : 0
  Statistics
    Hello
      Received             : 17214
      Sent                 : 95
    Membership
      Received             : 0
      Sent                 : 759
    Assert
      Received             : 0
      Sent                 : 0
```

API To access the Operational State API that corresponds to this CLI, click include::common:partial$operational_api_links.adoc[tag=show_pim_interface].

PIM Membership

Syntax:

show pim membership <option>

Option	Description
-	Without any option, the commands displays PIM membership summary on all instances.
instance <instance_name>	Displays the PIM membership summary information on specific instance.
detail	Detailed information on all BGP peers in all instances in a list view.
instance <instance_name> detail	Displays the PIM membership detailed information on specific instance.
<group_address>	Specifies the multicast multicast group address
<source_address>	Specifies the source from which the multicast traffic is received

Example 1: Summary of the PIM membership on all instances.

```
supervisor@rtbrick: op> show pim membership
Source                Group             Interface    Instance       Uptime
198.51.100.42         198.51.100.222    null0        default        00h:38m:05s
198.51.100.42         198.51.100.187    null0        default        00h:38m:05s
198.51.100.42         198.51.100.235    null0        default        00h:38m:05s
```

Example 2: Summary of the PIM membership for the specified instance.

```
supervisor@rtbrick: op> show pim membership instance default
Source                  Group             Interface     Instance       Uptime
198.51.100.42           198.51.100.222    null0         default        00h:38m:18s
198.51.100.42           198.51.100.187    null0         default        00h:38m:18s
198.51.100.42           198.51.100.235    null0         default        00h:38m:18s
```

Example 3: Detailed view of PIM membership on all instances.

```
supervisor@rtbrick: op> show pim membership detail
198.51.100.42, 198.51.100.222
  Instance           : default
  Outgoing interface : null0
  Source             : pim
  Subtype            : Join
  Subsource          : Static
  Uptime             : 00h:39m:29s
198.51.100.42, 198.51.100.187
  Instance           : default
  Outgoing interface : null0
  Source             : pim
  Subtype            : Join
  Subsource          : Static
  Uptime             : 00h:39m:29s
198.51.100.42, 198.51.100.235
  Instance           : default
  Outgoing interface : null0
  Source             : pim
  Subtype            : Join
  Subsource          : Static
  Uptime             : 00h:39m:29s
```

Example 4: Detailed view of PIM membership for the specified instance.

```
supervisor@rtbrick: op> show pim membership instance default detail
198.51.100.42, 198.51.100.222
  Instance           : default
  Outgoing interface : null0
  Source             : pim
  Subtype            : Join
  Subsource          : Static
  Uptime             : 00h:39m:39s
198.51.100.42, 198.51.100.187
  Instance           : default
  Outgoing interface : null0
  Source             : pim
  Subtype            : Join
  Subsource          : Static
  Uptime             : 00h:39m:39s
198.51.100.42, 198.51.100.235
  Instance           : default
  Outgoing interface : null0
  Source             : pim
  Subtype            : Join
```

```
  Subsource          : Static
  Uptime             : 00h:39m:39s
```

Example 5: Detailed view of PIM membership for the specified group-address and source-address in selected instance.

```
supervisor@rtbrick: op> show pim membership instance default 198.51.100.222 198.51.100.42
198.51.100.42, 198.51.100.222
  Instance           : default
  Outgoing interface : null0
  Source             : pim
  Subtype            : Join
  Subsource          : Static
  Uptime             : 00h:39m:50s
supervisor@rtbrick: op>
```

PIM Join and Prune

Syntax:

show pim join-prune <option>

Option	Description
-	Without any option, the commands displays join and prune summary command on all instances.
instance <instance_name>	Displays join and prune summary on a specific instance.
detail	Displays PIM join and prune detailed information on all instances.
instance <instance_name> detail	Displays detailed join and prune information in selected instance.
<group_address>	Displays PIM join and prune detailed information for a specific group on all instance
<source_address>	Specifies the source from which the multicast traffic is received.

Example 1: Summary of the PIM join and prune all instances.

```
supervisor@rtbrick: op> show pim join-prune
Source                Group           Upstream Interface    Instance
```

```
198.51.100.42          198.51.100.222    ifl-1/7/1/1          default
198.51.100.42          198.51.100.187    ifl-1/7/1/1          default
198.51.100.42          198.51.100.235    ifl-1/7/1/1          default
198.51.100.11          198.51.100.22     ifl-0/0/3/3          vpn1
198.51.100.11          198.51.100.217    ifl-0/0/3/3          vpn1
```

Example 2: Summary of the PIM join and prune summary for the specified instance.

```
supervisor@rtbrick: op> show pim join-prune instance vpn1
Source            Group               Upstream Interface  Instance
198.51.100.11     198.51.100.22       ifl-0/0/3/3         vpn1
198.51.100.11     198.51.100.217      ifl-0/0/3/3         vpn1
198.51.100.33     198.51.100.23       ifl-0/0/3/3         vpn1
198.51.100.40     198.51.100.24       ifl-0/0/3/3         vpn1
```

Example 3: Detailed view of the PIM join and prune for the specified instance.

```
supervisor@rtbrick: op> show pim join-prune instance vpn1 detail
198.51.100.11, 198.51.100.22
  Instance           : vpn1
  Upstream interface : ifl-0/0/3/3
  Upstream neighbor  : 198.51.100.11
  Type               : Join
  Uptime             : 00h:01m:11s
198.51.100.11, 198.51.100.217
  Instance           : vpn1
  Upstream interface : ifl-0/0/3/3
  Upstream neighbor  : 198.51.100.11
  Type               : Join
  Uptime             : 00h:01m:11s
198.51.100.33, 198.51.100.23
  Instance           : vpn1
  Upstream interface : ifl-0/0/3/3
  Upstream neighbor  : 198.51.100.33
  Type               : Join
  Uptime             : 00h:03m:41s
198.51.100.40, 198.51.100.24
  Instance           : vpn1
  Upstream interface : ifl-0/0/3/3
  Upstream neighbor  : 198.51.100.40
  Type               : Join
  Uptime             : 00h:03m:41s
198.51.100.66, 198.51.100.196
  Instance           : vpn1
  Upstream interface : ifl-0/0/3/3
  Upstream neighbor  : 198.51.100.66
  Type               : Join
  Uptime             : 00h:55m:31s
198.51.100.70, 198.51.100.197
  Instance           : vpn1
  Upstream interface : ifl-0/0/3/3
  Upstream neighbor  : 198.51.100.70
  Type               : Join
  Uptime             : 00h:55m:30s
198.51.100.80, 198.51.100.198
```

```
  Instance           : vpn1
  Upstream interface : ifl-0/0/3/3
  Upstream neighbor  : 198.51.100.80
  Type               : Join
  Uptime             : 00h:55m:30s
198.51.100.38, 198.51.100.199
  Instance           : vpn1
  Upstream interface : ifl-0/0/3/3
  Upstream neighbor  : 198.51.100.38
  Type               : Join
  Uptime             : 00h:55m:31s
198.51.100.200, 198.51.100.210
  Instance           : vpn1
  Upstream interface : ifl-0/0/3/3
  Upstream neighbor  : 198.51.100.200
  Type               : Join
  Uptime             : 00h:55m:31s
```

Example 4: Detailed view of the PIM join and prune for the specified instance, source, and group.

```
supervisor@rtbrick: op> show pim join-prune instance vpn1 198.51.100.210 198.51.100.200
198.51.100.200, 198.51.100.210
  Instance           : vpn1
  Upstream interface : ifl-0/0/3/3
  Upstream neighbor  : 198.51.100.200
  Type               : Join
  Uptime             : 00h:55m:50s
```

PIM Neighbors

Syntax:

show pim neighbor <option>

Option	Description
-	Without any option, the commands displays the PIM neighbor summary on all instances.
instance <instance_name>	Displays the PIM neighbor summary information on specific instance
instance <instance_name> <neighbor_address>	Displays detailed information for specific PIM neighbor in selected instance.

Example 1: Summary of PIM neighbor on all instances.

```
supervisor@rtbrick: op> show pim neighbor
Neighbor         Interface        Instance     Generation ID  Uptime         Expires
198.51.100.42    ifl-1/7/1/1      default      1413290566     00h:55m:34s    1m 35s
198.51.100.11    ifl-0/0/3/3      vpn1         666648646      00h:55m:59s    21s
198.51.100.37    ifl-0/0/3/3      vpn1         1893441310     00h:55m:59s    28s
198.51.100.33    ifl-0/0/3/3      vpn1         1582670973     00h:55m:56s    24s
198.51.100.40    ifl-0/0/3/3      vpn1         2114142516     00h:55m:59s    21s
198.51.100.50    ifl-0/0/3/3      vpn1         620803409      00h:55m:56s    29s
```

Example 2: Summary of PIM neighbor for the specified instance.

```
supervisor@rtbrick: op> show pim neighbor instance default
Neighbor         Interface           Instance       Generation ID  Uptime         Expires
198.51.100.42     ifl-1/7/1/1        default         1413290566  00h:55m:41s    1m 28s
```

Example 3: Detailed view of PIM neighbor for the specified instance.

```
supervisor@rtbrick: op> show pim neighbor instance default 198.51.100.42

Neighbor: 198.51.100.42
  Interface            : ifl-1/7/1/1
  Instance             : default
  Hold down interval   : 105s
  Expires              : 105s
  Generation ID        : 1413290566
  DR priority          : 1
  Uptime               : 00h:55m:47s
  Last transition time : Tue Nov 24 06:47:08 GMT +0000 2020
  Holddown received    : 1
```

API To access the Operational State API that corresponds to this CLI, click include::common:partial$operational_api_links.adoc[tag=show_pim_neighbor].

PIM Reverse Path Forwarding (RPF)

Syntax:

show pim rpf <option>

Option	Description
-	Without any option, the commands displays the PIM rpf summary information on all instance.
instance <instance_name>	Displays the PIM rpf summary information on specific instance.

Option	Description
instance <instance> <source_address>	Displays the PIM rpf detailed information for specific source-address in selected instance.

Example 1: Summary of PIM rpf on all instances.

```
supervisor@rtbrick: op> show pim rpf
Multicast Source  Instance       RPF Interface       Neighbor
198.51.100.42      default        ifl-1/7/1/1      198.51.100.42
198.51.100.11      vpn1           ifl-0/0/3/3      198.51.100.11
198.51.100.33      vpn1           ifl-0/0/3/3      198.51.100.33
198.51.100.40      vpn1           ifl-0/0/3/3      198.51.100.40
198.51.100.66      vpn1           ifl-0/0/3/3      198.51.100.66
198.51.100.107     vpn1           n/a              n/a
```

Example 2: Summary of PIM rpf for the specified instance.

```
supervisor@rtbrick: op> show pim rpf instance vpn1
Multicast Source  Instance       RPF Interface       Neighbor
198.51.100.11     vpn1         ifl-0/0/3/3      198.51.100.11
198.51.100.33     vpn1         ifl-0/0/3/3      198.51.100.33
198.51.100.40     vpn1         ifl-0/0/3/3      198.51.100.40
198.51.100.66     vpn1         ifl-0/0/3/3      198.51.100.66
198.51.100.70     vpn1         ifl-0/0/3/3      198.51.100.70
198.51.100.107    vpn1         n/a                 n/a
```

Example 3: Detailed view of PIM rpf for the specified source-address in selected instance.

```
supervisor@rtbrick: op> show pim rpf instance vpn1 198.51.100.11
Multicast source : 198.51.100.11
  Instance        : vpn1
  AFI             : ipv4
  SAFI            : unicast
  RPF interface   : ifl-0/0/3/3
  Peer            : 198.51.100.11
  Covering prefix : n/a
  MAC address     : 00:12:01:00:00:01
```

PIM Routes

Syntax:

show pim mroute <option>

Option	Description
-	Without any option, the commands displays the PIM routes summary information on all instance.
detail	Displays the PIM routes detail for all instances.
instance <instance_name>	Displays the PIM routes summary on specific instance
instance <instance_name> detail	Displays the PIM routes detailed information on specific instances.

Example 1: Summary of PIM routes for all instances.

```
supervisor@rtbrick: op> show pim mroute
Instance: default, AFI: ipv4, SAFI: multicast
  Source             Group              Route Source   Preference  Nexthop            OIF
  198.51.100.42      198.51.100.222   pim            240         n/a                null0
  198.51.100.42      198.51.100.187   pim            240         n/a                null0
  198.51.100.42      198.51.100.235   pim            240         n/a                null0
```

Example 2: Detailed view of PIM routes for all instances.

```
supervisor@rtbrick: op> show pim mroute detail
198.51.100.42, 198.51.100.222
  Source       : pim                    Preference       : 240
  Sub source   : Static                 Subtype          : Join
  RPF neighbor : 198.51.100.42          RPF interface    : ifl-1/7/1/1
  Nexthop      : n/a                    Egress interface : null0
  Nexthop type : Multicast Fanout       NextHop action   : None
  Destination  : default-ipv4-multicast
  Resolved in  : default-ipv4-multicast
198.51.100.42, 198.51.100.187
  Source       : pim                    Preference       : 240
  Sub source   : Static                 Subtype          : Join
  RPF neighbor : 198.51.100.42          RPF interface    : ifl-1/7/1/1
  Nexthop      : n/a                    Egress interface : null0
  Nexthop type : Multicast Fanout       NextHop action   : None
  Destination  : default-ipv4-multicast
  Resolved in  : default-ipv4-multicast
198.51.100.42, 198.51.100.235
  Source       : pim                    Preference       : 240
  Sub source   : Static                 Subtype          : Join
  RPF neighbor : 198.51.100.42          RPF interface    : ifl-1/7/1/1
  Nexthop      : n/a                    Egress interface : null0
  Nexthop type : Multicast Fanout       NextHop action   : None
  Destination  : default-ipv4-multicast
  Resolved in  : default-ipv4-multicast
```

Example 3: Summary of PIM routes for the specific instance.

```
supervisor@rtbrick: op> show pim mroute instance default
Instance: default, AFI: ipv4, SAFI: multicast
```

```
  Source             Group               Route Source   Preference  Nexthop             OIF
  198.51.100.96    198.51.100.222   pim           240         n/a                 null0
  198.51.100.96    198.51.100.187   pim           240         n/a                 null0
  198.51.100.96    198.51.100.235   pim           240         n/a                 null0
```

Example 4: Detailed view of PIM routes for the specified instances.

```
supervisor@rtbrick: op> show pim mroute instance default detail
198.51.100.96, 198.51.100.222
  Source       : pim                    Preference       : 240
  Sub source   : Static                 Subtype          : Join
  RPF neighbor : 198.51.100.96          RPF interface    : ifl-1/7/1/1
  Nexthop      : n/a                    Egress interface : null0
  Nexthop type : Multicast Fanout       NextHop action   : None
  Destination  : default-ipv4-multicast
  Resolved in  : default-ipv4-multicast
198.51.100.96, 198.51.100.187
  Source       : pim                    Preference       : 240
  Sub source   : Static                 Subtype          : Join
  RPF neighbor : 198.51.100.96          RPF interface    : ifl-1/7/1/1
  Nexthop      : n/a                    Egress interface : null0
  Nexthop type : Multicast Fanout       NextHop action   : None
  Destination  : default-ipv4-multicast
  Resolved in  : default-ipv4-multicast
198.51.100.96, 198.51.100.235
  Source       : pim                    Preference       : 240
  Sub source   : Static                 Subtype          : Join
  RPF neighbor : 198.51.100.96          RPF interface    : ifl-1/7/1/1
  Nexthop      : n/a                    Egress interface : null0
  Nexthop type : Multicast Fanout       NextHop action   : None
  Destination  : default-ipv4-multicast
  Resolved in  : default-ipv4-multicast
```

API To access the Operational State API that corresponds to this CLI, click include::common:partial$operational_api_links.adoc[tag=show_pim_mroute].

PIM Clear Commands

Clear commands allow to reset operational states.

PIM Neighbor

Syntax:

clear pim neighbor

Option	Description
neighbor	Clears all neighbors.

Example: The example below shows how to clear pim neighbor.

```
supervisor@rtbrick: op> clear pim neighbor
All instance clear triggered
```

PIM Neighbor Instance

Syntax:

clear pim neighbor instance <option> ...

Option	Description
neighbor instance <instance_name>	Clears all neighbors on the specified instance.
neighbor instance <instance_name> interface <interface-name>	Clears all neighbors on the specified interface.

Example 1: The example below shows how to clear neighbors of the specified instance

```
supervisor@rtbrick: op> clear pim neighbor instance vrf1
Instance clear triggered
```

Example 2: The example below shows how to clear neighbors of the specified interface

```
supervisor@rtbrick: op> clear pim neighbor instance vrf1 interface ifl-0/0/0
Instance clear triggered
```

8.3. Multicast VPN

8.3.1. MVPN Overview

The Multicast VPN (MVPN) feature provides the ability to support multicast over a Layer 3 VPN. Multicast allows the efficient distribution of information between a

single multicast source and multiple receivers. IP multicast is used to stream video, voice, and data to an MPLS VPN network core. The RBFS MVPN implementation is based on RFC 6513 “Multicast in MPLS/BGP IP VPNs” and RFC 6514 “BGP Encodings and Procedures for Multicast in MPLS/BGP IP VPNs”.

RFC and draft compliance are partial except as specified.

RBFS can operate in a spine/leaf fabric as shown in the diagram. The leaf device delivers access services to subscribers or assets, and the spine device provides connectivity to the core network. In such a scenario, IPv4 multicast traffic is carried in a multicast VPN instance. This also allows to deliver IPv4 multicast traffic across an IPv6-only fabric. In terms of MVPN, both leaf and spine devices act as Provider Edge (PE) routers.

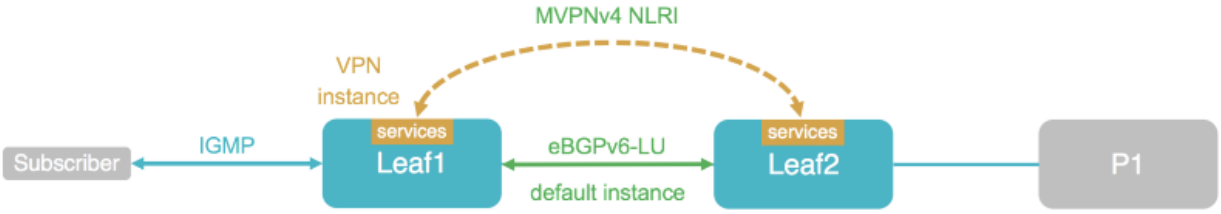


Figure 148. Multicast VPN Scenario

Multicast subscribers will typically join multicast streams via IGMP. Leaf switches will translate and signal the join messages to the spines using BGP MVPN routes. Spine switches will further forward the join messages towards the source to the upstream core router.

Multicast Address Families

In MVPN, there are two types of instances that address families involved:

- Within the multicast VPN instance, joins are represented as multicast routes. These are AFI 1 (IPv4), SAFI 2 (Multicast). The IPv4 multicast address family needs to be enabled in the VPN service instance as well as for BGP in the VPN instance.
- In the Multicast VPN itself, messages like joins or active sources are advertised using BGP MVPN routes. These are AFI 1 (IPv4), SAFI 5 (MVPN). The BGP peerings that carry the MVPN routes typically run in the default instance. Therefore the MVPN address family needs to be enabled in the default instance, both for the BGP instance itself as well as for the BGP peerings.

In summary, the following address families need to be enabled by configuration:

- The IPv4 multicast address family in the VPN service instance.
- The IPv4 multicast address family for BGP in the VPN service instance.
- The Multicast VPN address family in the BGP default instance.
- The Multicast VPN address family in the BGP peerings in the default instance.

Supported Platforms

Not all features are necessarily supported on each hardware platform. Refer to the *Platform Guide* for the features and the sub-features that are or are not supported by each platform.

8.3.2. MVPN Configuration

Configuration Hierarchy

The diagram illustrates the Multicast VPN configuration hierarchy.

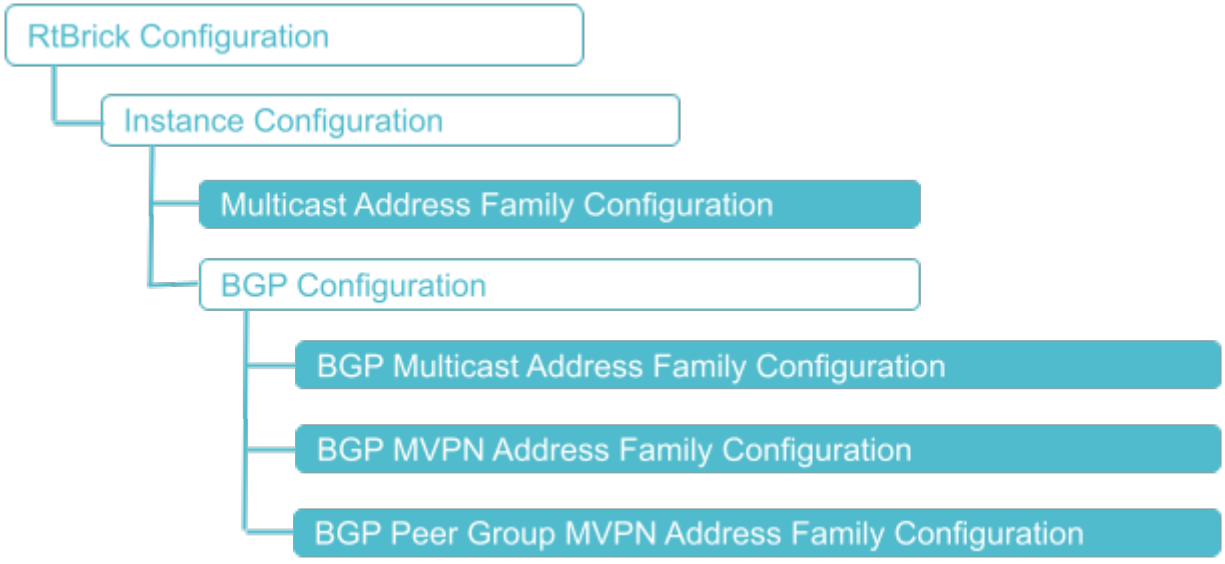


Figure 149. Multicast VPN Configuration Hierarchy

Configuration Syntax and Commands

The following sections describe the MVPN configuration syntax and commands.

Multicast Address Family Configuration

Enable the IPv4 multicast address family in the VPN service instance.

Syntax:

set instance <instance> **address-family** <afi> <safi> <attribute> <value>

Attribute	Description
<instance>	The name of the VPN service instance
<afi>	Address family identifier (AFI). For IPv4 multicast, the required value is: ipv4
<safi>	Subsequent address family identifier (SAFI). For IPv4 multicast, the required value is: multicast

Example: Instance Address Family Configuration

```
{
  "ietf-restconf:data": {
    "rtbrick-config:instance": [
      {
        "name": "services",
        "address-family": [
          {
            "afi": "ipv4",
            "safi": "multicast",
            "route-target": {
              "import": "target:198.51.100.10:13",
              "export": "target:198.51.100.10:13"
            }
          }
        ]
      }
    ]
  }
}
```

BGP Multicast Address Family Configuration

Enable the IPv4 multicast address family for BGP in the VPN service instance.

Syntax:

set instance <instance> protocol bgp **address-family** <afi> <safi>

```
<attribute> <value>
```

Attribute	Description
<instance>	The name of the VPN service instance
<afi>	Address family identifier (AFI). For IPv4 multicast, the required value is: ipv4
<safi>	Subsequent address family identifier (SAFI). For IPv4 multicast, the required value is: multicast
redistribute <source>	Optionally redistribute PIM routes into BGP to translate and advertise subscriber join message as MVPN routes. The required source value is pim as IGMP routes are handled by the PIM process too.

Example: Instance BGP Address Family Configuration

```
{
  "ietf-restconf:data": {
  "rtbrick-config:instance": {
    "name": "services",
    "protocol": {
      "bgp": {
        "address-family": [
          {
            "afi": "ipv4",
            "safi": "multicast",
            "redistribute": [
              {
                "source": "pim"
              }
            ]
          }
        ]
      }
    }
  }
}
```

BGP MVPN Address Family Configuration

Enable the MVPN address family in the global BGP instance.

Syntax:

```
set instance <instance> protocol bgp address-family <afi> <safi>
```

<attribute> <value>

Attribute	Description
<instance>	Name of the global BGP instance. Typically this will be the default instance.
<afi>	Address family identifier (AFI). For MVPN, the required value is: ipv4
<safi>	Supported SAFIs are unicast. For MVPN, the required value is: vpn-multicast

Example: BGP MVPN Address Family Configuration

```
{
  "ietf-restconf:data": {
    "rtbrick-config:instance": [
      {
        "name": "default",
        "protocol": {
          "bgp": {
            "address-family": [
              {
                "afi": "ipv4",
                "safi": "vpn-multicast"
              }
            ]
          }
        }
      }
    ]
  }
}
```

BGP Peer Group MVPN Address Family Configuration

Enable the MVPN address family for the global BGP peerings carrying the MVPN routes.

Syntax:

set instance <instance> **protocol bgp peer-group** <attribute> <value>

Attribute	Description
<instance>	Name of the global BGP instance. Typically this will be the default instance.
<pg-name>	Peer group name
address-family <afi> <safi>	BGP peer group address family specific. For MVPN, the required AFI/SAFI values are: ipv4/ vpn-multicast.

Example: BGP Peer Group MVPN Address Family Configuration

```
{
  "ietf-restconf:data": {
    "rtbrick-config:peer-group": [
      {
        "pg-name": "spine",
        "address-family": [
          {
            "afi": "ipv4",
            "safi": "vpn-multicast",
            "extended-nexthop": "true",
            "update-nexthop": {
              "ipv6-address": "2001:db8:0:103::"
            }
          }
        ]
      }
    ]
  }
```

Multicast VPN Configuration Example

```
{
  "ietf-restconf:data": {
    "rtbrick-config:instance": [
      {
        "name": "default",
        "protocol": {
          "bgp": {
            "address-family": [
              {
                "afi": "ipv4",
                "safi": "vpn-multicast"
              }
            ],
            "peer-group": [
              {
                "pg-name": "spine",
                "address-family": [
                  {
                    "afi": "ipv4",
                    "safi": "vpn-multicast",
                    "extended-nexthop": "true",
```

```
                    "update-nexthop": {
                      "ipv6-address": "2001:db8:0:103::"
                    }
                  }
                ]
              }
            ]
          }
        }
      },
      {
        "name": "services",
        "address-family": [
          {
            "afi": "ipv4",
            "safi": "multicast",
            "route-target": {
              "import": "target:198.51.100.10:13",
              "export": "target:198.51.100.10:13"
            }
          }
        ],
        "protocol": {
          "bgp": {
            "address-family": [
              {
                "afi": "ipv4",
                "safi": "multicast",
                "redistribute": [
                  {
                    "source": "pim"
                  }
                ]
              }
            ]
          }
        }
      }
    ]
  }
}
```

8.3.3. MVPN Operational Commands

Show Commands

Syntax:

show mroute <options>

Option	Description
-	Without any option, the commands displays summary of all the multicast routes.
all	Displays multicast routes for all the VPN instances.
detail	Displays detailed view of all the multicast routes including the statistics and ingress interface details.
detail all	Displays detailed view of all the multicast routes for all the VPN instances.
instance <vpn-instance-name>	Name of the VPN instance
group <group-address>	Multicast group address
<ipv4|ipv6> instance <instance_name> source <source-address>	Multicast source address

The following example output shows the mroute details for two PPPoE subscribers joining two different multicast group, where it displays the multicast traffic statistics along with nexthop information, ingress and egress interface.



Multicast traffic statistics is fetched at an interval of 60 seconds

```
supervisor@rtbrick.net: cfg> show mroute detail
Instance: service, AFI: ipv4, SAFI: multicast
198.51.100.251/32, 232.1.1.1/32
  Source: pim, Preference: 250
  Forwarded packets: 103199, Forwarded bytes: 8255920, Forwarded pps: 1000
  Dropped packets: 0, Dropped bytes: 0, Dropped pps: 0
      Next Hop type: Multicast Fanout, Next Hop action: PPPoE Replicate
      Resolved in: ip2vrf-ipv4-multicast
      Egress interface: ppp-0/0/4/72339069014638596
      Ingress interface: ifl-0/0/2/21
198.51.100.252/32, 232.1.1.2/32
  Source: pim, Preference: 250
  Forwarded packets: 103188, Forwarded bytes: 8255040, Forwarded pps: 1000
  Dropped packets: 0, Dropped bytes: 0, Dropped pps: 0
      Next Hop type: Multicast Fanout, Next Hop action: PPPoE Replicate
      Resolved in: ip2vrf-ipv4-multicast
      Egress interface: ppp-0/0/4/72339069014638597
      Ingress interface: ifl-0/0/2/21
supervisor@rtbrick.net: cfg>
```

MVPN Route Show Commands

Syntax:

show bgp fib ipv4 vpn-multicast instance default <attribute> <value>

Option	Description
-	Without any option, the commands displays summary of all the multicast routes.
detail	Displays detailed view of all the VPN multicast routes.
<prefix>	Destination prefix address

Example: Display MVPN Route Summary Information

```
supervisor@rtbrick: op> show bgp fib ipv4 vpn-multicast instance default
Flags: & - Imported, ! - Error
Instance: default, AFI: ipv4, SAFI: vpn-multicast
  Hostname: PE1, Peer IP: 12::1
  Source IP: 12::2, Total routes: 6
    Flags  Group          Source              Next Hop     MED    Lpref   AS Path
Route Type            Originator ID
           -              -                   12::1        -      100     -
Intra-AS_I-PMSI_AD    192.168.3.10
           -              -                   12::1        -      100     -
Intra-AS_I-PMSI_AD    192.168.4.10
           232.1.1.1/32   198.51.100.251/32   12::1        -      100     -
Source_Tree_Join      -
```

Clear Commands

Clearing Multicast Statistics

Use the clear multicast statistics command to reset multicast traffic counters to zero. After the command completes successfully, the counters begin collecting new statistics.

Syntax:

clear multicast statistics

The example below shows the output of the "show mroute detail" command

before clearing the statistics.

```
supervisor@rtbrick.net: cfg> show mroute detail
Instance: service, AFI: ipv4, SAFI: multicast
198.51.100.251/32, 232.1.1.1/32
  Source: pim, Preference: 250
  Forwarded packets: 103199, Forwarded bytes: 8255920, Forwarded pps: 1000
  Dropped packets: 0, Dropped bytes: 0, Dropped pps: 0
      Next Hop type: Multicast Fanout, Next Hop action: PPPoE Replicate
      Resolved in: ip2vrf-ipv4-multicast
      Egress interface: ppp-0/0/4/72339069014638596
      Ingress interface: ifl-0/0/2/21
198.51.100.252/32, 232.1.1.2/32
  Source: pim, Preference: 250
  Forwarded packets: 103188, Forwarded bytes: 8255040, Forwarded pps: 1000
  Dropped packets: 0, Dropped bytes: 0, Dropped pps: 0
      Next Hop type: Multicast Fanout, Next Hop action: PPPoE Replicate
      Resolved in: ip2vrf-ipv4-multicast
      Egress interface: ppp-0/0/4/72339069014638597
      Ingress interface: ifl-0/0/2/21
supervisor@rtbrick.net: cfg>
```

The example below shows the command to clear multicast statistics.

```
supervisor@rtbrick.net: cfg> clear multicast statistics
Success : command success
```

The example below shows the output of the "show mroute detail" command after clearing the statistics.

```
supervisor@rtbrick.net: cfg> show mroute detail
Instance: service, AFI: ipv4, SAFI: multicast
198.51.100.251/32, 232.1.1.1/32
  Source: pim, Preference: 250
  Forwarded packets: 0, Forwarded bytes: 0, Forwarded pps: 0
  Dropped packets: 0, Dropped bytes: 0, Dropped pps: 0
      Next Hop type: Multicast Fanout, Next Hop action: PPPoE Replicate
      Resolved in: ip2vrf-ipv4-multicast
      Egress interface: ppp-0/0/4/72339069014638596
      Ingress interface: ifl-0/0/2/21
198.51.100.252/32, 232.1.1.2/32
  Source: pim, Preference: 250
  Forwarded packets: 0, Forwarded bytes: 0, Forwarded pps: 0
  Dropped packets: 0, Dropped bytes: 0, Dropped pps: 0
      Next Hop type: Multicast Fanout, Next Hop action: PPPoE Replicate
      Resolved in: ip2vrf-ipv4-multicast
      Egress interface: ppp-0/0/4/72339069014638597
      Ingress interface: ifl-0/0/2/21
supervisor@rtbrick.net: cfg>
```

9. Security

9.1. Securing Management Plane

9.1.1. Securing the Management Plane Overview

The Securing Management Plane feature provides the capability to restrict the access to the management plane only to authenticated and authorized subjects.

The authentication identifies a subject, and the authorization validates if the subject is allowed to execute the action.

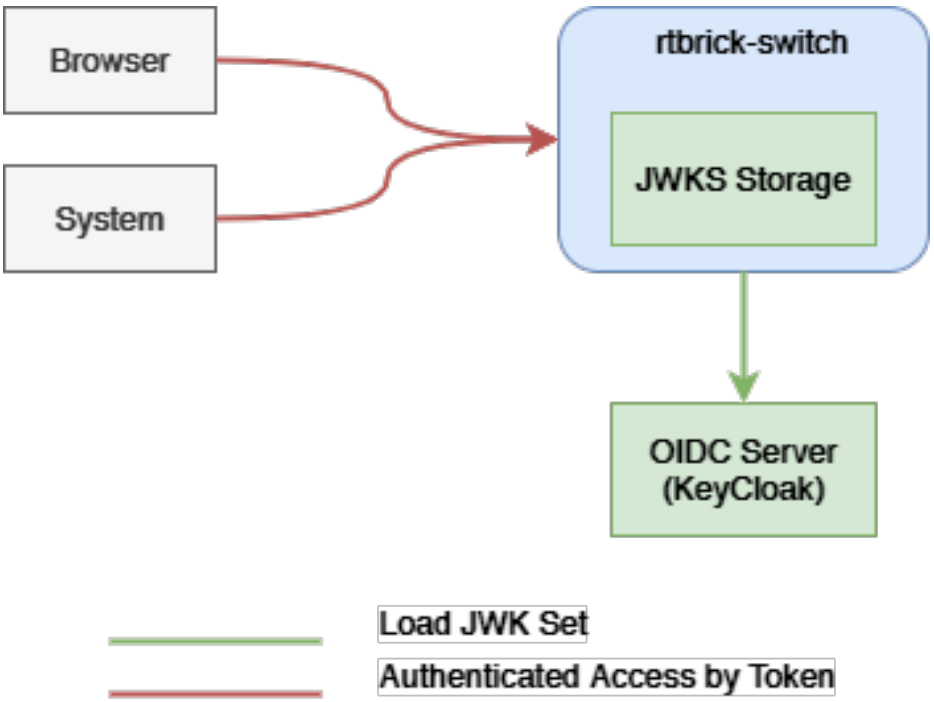


Figure 150. External Dataflow

The figure-1 shows the data flow when accessing an rtbrick-switch. Each call against the switch in more detail against the API Gateway Daemon (APIGWD) of the switch has to be authenticated with an access token. There is only one exception when accessing the CTLRD's UI; it is possible to be redirected to an OpenIDConnect Authenticator.

The APIGWD validates the access token against an JSON Web Key Set (JWKS) (https://tools.ietf.org/html/rfc7517). This key set can be loaded from a file locally on the system or auto discovered via the OpenIDConnect server.

A valid access token, in the sense of syntactically correct but also successfully validated signature by one of the JSON Web Key of the JWKS files, leads in an authenticated user. If the validation is unsuccessful, the call will be rejected.

The access token contains scopes which are used internally for the authorization checks. The authorization is a role based authorization where the scopes equal to the roles.

Internally the access token is converted to an RtBrick token, and all the communications inside the switch is authenticated via this RtBrick token.

The dataflow inside of the switch can be seen in Figure 2.

The scopes of the access token are copied to the RtBrick Token.

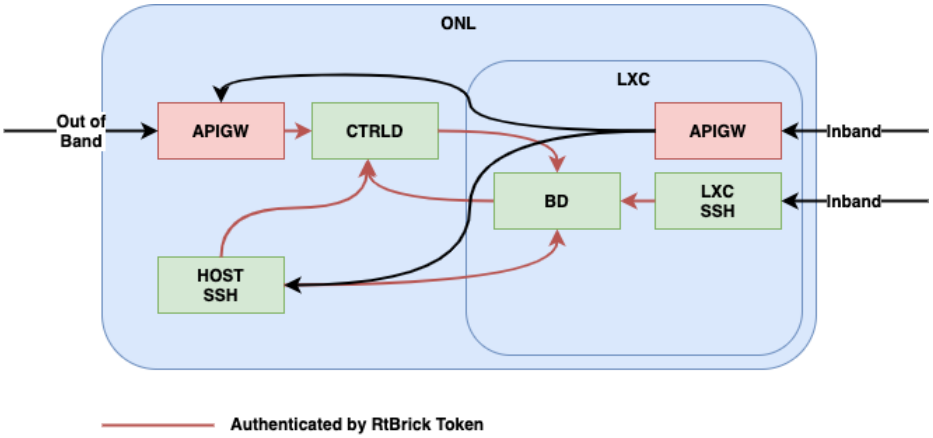


Figure 151. Internal Dataflow

Supported Platforms

Not all features are necessarily supported on each hardware platform. Refer to the *Platform Guide* for the features and the sub-features that are or are not supported by each platform.

9.1.2. RtBrick Token

JSON Web Tokens

JSON Web Token (JWT) is an open standard (RFC 7519) that defines a compact and self-contained way for securely transmitting information between parties as a JSON object.

This information can be verified and trusted because it is digitally signed. JWTs can

be signed using a secret (with the HMAC algorithm) or a public/private key pair using RSA or ECDSA.



RFC and draft compliance are partial except as specified.

For more information about JSON Web Token, see https://jwt.io/introduction/.

Structure

In its compact form, JSON Web Tokens consist of three parts separated by dots (.), which are:

- Header
- Payload
- Signature

Therefore, a JWT typically looks like the following.

```
xxxxx.yyyyy.zzzzz
```

Header

The header typically consists of two parts:

- The **type of the token**, which is JWT
- The signing algorithm that is being used, such as HMAC SHA256 or RSA

The suite of specifications on JWT provisions a few different options to identify particular cryptographic keys. The most straightforward mechanism is the "kid" claim. This claim can be added to the header of the token. It is intended to contain a string-based key identifier.

For example:

```
{
  "alg": "HS256",
  "typ": "JWT",
  "kid": "0815"
}
```

Then, this JSON is Base64Url encoded to form the first part of the JWT.

Payload

The second part of the token is the **payload**, which contains the claims. Claims are statements about an entity (typically, the user) and additional data.

There are three types of claims:

- registered
- public
- private

Registered claims

These are a set of predefined claims which are not mandatory but recommended, to provide a set of useful, interoperable claims. Some of them are: iss (issuer), exp (expiration time), sub (subject), aud (audience), and others.

Public claims

These can be defined at will by those using JWTs. But to avoid collisions they should be defined in the IANA JSON Web Token Registry or be defined as a URI that contains a collision resistant namespace.

Private claims

These are the custom claims created to share information between parties that agree on using them and are neither registered or public claims.

An example payload is as follows:

```
{
  "sub": "1234567890",
  "name": "John Doe",
  "iat": 1516239022,
  "exp": 1600000000,
  "scope": "user"
}
```

The payload is then Base64Url encoded to form the second part of the JSON Web Token.

Signature

To create the signature part you have to take the encoded header, the encoded

payload, a secret, the algorithm specified in the header, and sign that.

For example if you want to use the HMAC SHA256 algorithm, the signature will be created in the following way:

```
HMACSHA256(
  base64UrlEncode(header) + "." +
  base64UrlEncode(payload),
  secret)
```

The signature is used to verify the message wasn't changed along the way, and, in the case of tokens signed with a private key, it can also verify that the sender of the JWT is who it says it is.

Putting all together

The output is three Base64-URL strings separated by dots that can be easily passed in HTML and HTTP environments.

AccessToken

The Access Token is a JSON Web Token. The token is typically sent in the Authorization header using the Bearer schema. The content of the header should look like the following:

```
Authorization: Bearer <token>
```

The API Gateway also supports sending the token as Cookie, but this is not described here, that is only used for the CTRLD web UI.

The token has to have the kid claim in the header. This kid is used to find the right JSON Web Key (JWK) from one of the JSON Web Key Sets (JWKS).

APIGWD searches for the jwks file under /etc/rtbrick/apigwd/access_secret_jwks.json, but it is also possible to provide an additional oicd endpoint. By that the keysets are searched in the provided order:

- local file specified by command line -access-token-jwks-file-name
- oicd auto discovery -oidc-issuer

The scope claim contains the roles the user has. For example:

```
{
  "sub": "1234567890",
  "name": "John Doe",
  "admin": true,
  "iat": 1516239022,
  "exp": 1600000000,
  "scope": "user operator"
}
```


This user has the roles user and operator.

JWKS Validation

The example below shows how to create a public/private key set file (for example with https://mkjwk.org/)



Figure 152. JWKS Validation

Example PubPrivJwks.json:


```
{
  "keys": [
    {
      "p": "-
3WNqU2aWKy8Q7mblRpw_aOknW47YvZKVNQzlWdijXW5E1hQ5c6sfjqo92pq5mNKJ_Xkl71xHyp-WBfw-
xJqZ9pUuG4jnUiKgzYHvkccDF5XIMrpA67VnBozmyLckQOKEXesRD2hacrjb-
T89dcIZQHBUK1RYXGRxHCM_hPeBok",
      "kty": "RSA",
      "q": "07STzbuUh6p_iN2wzTegIQdnXBLnzPObCKt-KLSjkLtrZMv2YxM2yhMs-
56SsLR7EICFRAB2vdCzlovXKShubU9NSKgVI38qpGV9hii8rqN5N3dEM4Gscp_TR36ex1NoSC6kHBF2hsy
PfgD7U-txguZr6w9MN6rK4bAcg0TWGM0",
      "d": "IWcC4aKuPVlVGZeBhb3mla1mOsOcJuLxjpkZAu-
QaQO7phWzeGLEfln3tojKtIK6e11FEz137ow75Je0_oMAzE-
eTAMyseUTHZhn4LhmIdOwnsp9OZrMbNmLFpaF_rGYb0630xg27GdR4gC_lZvMuy1uCP1sr8Iyl1ujN7n_6
ETMYbdXPLOtEAB4Dag6XFTjy1l8aVvBxpscm8gKg64fgBGRvGY6PiUfqY3gaq_vX9SOOHVPN5WoShKA4fg
uxukRBiLLYNxDMDb3-h8pd1_fr2WayDzmcIXpxvVjRVZHt71C-
0Uhap6eRDMQocZXih8IdNV8zHUF_LeciE36fIb3oQ",
      "e": "AQAB",
      "use": "sig",
      "kid": "access",
      "qi": "3His_DaBkf_r7uDx9-8BOhOQPhcudT95XC9WyS5MrYIBtgqQi6IscHIqvtXFpjmPRey-
chO7p9msOAB_T8j_mg1l6UWOx6j4h_fyHEbOwRqfNemKng2Hs0uCrwpjgGf2eXzaBY8T9HlbFlTJAAARGh
_PePBi-F-IfAxGayj4hiM",
      "dp": "NJuYYpZAt1KUJJsdSKl6gCYPV3xrYj3iuTKYBCbYAH5jlP-
CFUIS5mnBVdnmuYKGTivsgi55DysluapwmSZ2KnoMBXXNb6dwixjvr8hSvuex1MN-
0m1udTUqHMfDW3dhGFxwJuq57VcsFAnVPl2ZfQBMAGPyRa-r7mwZo0Jmzfk",
      "alg": "RS256",
      "dq": "XL-
```

```
4IWIU6Hrh9OxrEP1VwiKkPcpqk3gGa_31_49kOXxiyH4zK6S3VECibHpEefYYFFq6B9jMLMzKYSJS2U1FU
85yZWp-GFcWL3_nRmeCgmBMMuilkIs3KeCrh58JoPoBrd4BN-rOqq_kDagQc-
uqh1a74PeKxLimucmWNExsH-E",
      "n": "z_NDmLu8M3KGvxvfJt8CAhdLdsqkskfY7vf9X9pW1LE_r31_HU85-
l6NNHeUWYbSNe6lt9YODnL8-
vTT6oCgre96byvpdYZ7Ki5KGe4fU96x0_ZF5LceUQc4l5dx6aptNi9mWgcZ9nkc2Xh83ASg9otG2YoYsAn
I1cO0TjzV9cMI7u7VON6SON9wbWFY01--ixMqxRAZuEJjbg4QAdL7DndRQXvmq1m7lv-
nnPPQ0a7ZTg7NZDEn5lMmadUlTVl5uvSNsACtC49R5kEkNCc1Hc-
3gootU5VyVPBx6IFHtNC2BiGasQAUpsDXZl7YtvBZwzYZwznUlluPiKLDk-4TtQ"
    }
  ]
}
```

The APIGWD only needs to know the Public part:

```
{
 "keys": [
 {
     "kty": "RSA",
     "e": "AQAB",
     "use": "sig",
     "kid": "access",
     "alg": "RS256",
     "n": "z_NDmLu8M3KGvxvfJt8CAhdLdsqkskfY7vf9X9pW1LE_r31_HU85-
l6NNHeUWYbSNe6lt9YODnL8-
vTT6oCgre96byvpdYZ7Ki5KGe4fU96x0_ZF5LceUQc4l5dx6aptNi9mWgcZ9nkc2Xh83ASg9otG2YoYsAn
I1cO0TjzV9cMI7u7VON6SON9wbWFY01--ixMqxRAZuEJjbg4QAdL7DndRQXvmq1m7lv-
nnPPQ0a7ZTg7NZDEn5lMmadUlTVl5uvSNsACtC49R5kEkNCc1Hc-
3gootU5VyVPBx6IFHtNC2BiGasQAUpsDXZl7YtvBZwzYZwznUlluPiKLDk-4TtQ"
   }
 ]
}
```

Now to create a token you can use https://keytool.online/, and paste the PubPrivJwks.json into the RSA Key Field and provide as Payload.

For example:

```
{
  "sub": "1234567890",
  "scope": "user operator",
  "name": "John Doe",
  "admin": true,
  "exp": 1600000000,
  "iat": 1516239022
}
```

This results in the following token:

```
eyJraWQiOiJhY2Nlc3MiLCJ0eXAiOiJKV1QiLCJhbGciOiJSUzI1NiJ9.eyJzdWIiOiIxMjM0NTY3ODkwI
iwic2NvcGUiOiJ1c2VyIG9wZXJhdG9yIiwibmFtZSI6IkpvaG4gRG9lIiwiYWRtaW4iOnRydWUsImV4cCI
6MTYwMDAwMDAwMCwiaWF0IjoxNTE2MjM5MDIyfQ.mP0mXR96-
```

```
9gYIzh6_2saUQckKDwpC7jDFpo2m0g9YAj4DkSf4xDoxBqMRwFkntLC6NV0sxyUNzC-
nv5yBretJAbbX_hCMS5Jk392piCVMt9ucbwnCKs6xaJDJmMHI1qxyf7lCgd9nIlawme4_nQnMJ4N9RdVeI
uyv1siuNUOo9RdSE4cX2JIzlrjgoZmtcU-
nq_I7S2QTkdro2e1wPZKktTMAoG6VjGb7ieIQ5XyLKNQt9PWSZ2sHkd85MxXMRUWUcrEagW6JrV3uixeT3
QTZ3g9Y6Qb4XDPH3EXUoAHJ0V26rpqXDsB_nmNvI5CVvCUcaZLPYoSEzBUPa9NaFIBcg
```

The apigwd can decode that token and validates the token with the corresponding key in the specified JKWS file.

OIDC Authentication

If you use OpenID Connect for Authentication, that the Token is generated by the OIDC Connect server.

It is important to understand how the validation of the tokens works. Either the JWKS file which corresponds to the OIDC server is located locally on the system, or the OpenID Connect Server (issuer) is specified.

The first configuration possibility we already discussed. If the oicd connect server is specified the server provides an endpoint where the clients can download the public keys.

As an example for this configuration of an oidc-issuer here an excerpt of:

/etc/rtbrick/apigwd/config.json

```
    "oidc_issuer" : "http://<keycloak>/auth/realms/<real name>",
    "client_id" : "<client id>",
    "client_secret" : "<secret>",
    "redirect_url": "",
```

Specific information about the issuer can be found at http://<keycloak>/auth/realms/<realm name>/.well-known/openid-configuration.

If you also specify the client secret and the client id, this allows the APIGWD to redirect to the login page of the OIDC server. This is needed for browser-based applications like CTRLD UI.

9.1.3. Role Based Access Control (RBAC)

Role Based Access Control (RBAC) is an approach to restrict the system access to authorized users. The authorization model is role-based. There will be three items in a role-based modeel: sub, obj, and act.

- **sub**: the user (role) that wants to access a resource.
- **obj**: the resource that is going to be accessed
- **act**: the operation that the user performs on the resource

The RBAC Data Model is implemented in RBFS, and it allows you to define Permission or User Roles to various type of resources.

The model contains:

- **Resource Type**: The type of resource we are talking about (for example, BDS Table, BDS Object, REST)
- **Resource**: The identifier of the Resource (for example, Table Name, Rest endpoints). Regular expressions are allowed.
- **Permissions**: Indicates the action that a user is allowed to perform on the resource. The Permissions are CRUD (Create, Read Update, Delete). The permission gets a semantic with respect to the resource type.
- **Role**: The role of a user who tries to access a resource.

CTRLD Authorization Configuration

Activate or Deactivate Authorization in CTRLD

```
"auth_disabled": true
```

It is possible to specify the permissions in CTRLD exactly in the way specified above.

Where sub is the role a user needs to have, obj species the url endpoint the user wants to reach, and act is the HTTP Method the user wants to call on the endpoint.

For example:

```
{
 "permissions": [
   {"sub": "supervisor", "obj": "/*", "act": ".*" },
   {"sub": "reader", "obj": "/*", "act": "GET"},
   {"sub": ".*", "obj":
"/api/v1/rbfs/elements/\{element_name}/services/\{service_name}/proxy/*", "act":
".*"}
 ]
```

```
}
```



- The user with the role supervisor is allowed to access all rest endpoints, and act on them with all HTTP methods.
- The user with the role reader is allowed to access all rest endpoints, but can only call the HTTP GET method.
- All authenticated users are allowed to access the proxy endpoint with all HTTP methods.

To configure that policy CTRLD offers 2 endpoints:

- PUT /api/v1/ctrld/authorization/permissions
- GET /api/v1/ctrld/authorization/permissions

Please refer to API Documentation for more information.

RBFS Authorization configuration

RBFS Role Configuration via REST

```
{
 "objects": [
   { "attribute": { "role": "operator", "permission": "create|read|delete",
"resource_regex": "global.*", "resource_type": "object" } },
   { "attribute": { "role": "operator", "permission": "create|read|delete",
"resource_regex": "global.*", "resource_type": "table" } }
 ],
 "table": { "table_name": "secure.global.rbac.authorization.config", "table_type":
"authorization_config_table" }
}

{
 "objects": [
   { "attribute": { "role": "user", "permission": "-|read|-", "resource_regex":
"global.*", "resource_type": "table" } },
   { "attribute": { "role": "user", "permission": "-|read|-", "resource_regex":
"global.*", "resource_type": "object" } }
 ],
 "table": { "table_name": "secure.global.rbac.authorization.config", "table_type":
"authorization_config_table" }
}
```

- **role** : Represents role in the system
- **resource_type** : Represents resources in the RBFS (table|object).
- **resource_regex** : Regex for the resources to be accessed.

- **permission** : Bitmap representing permissions to create, read and delete. create|read|delete

Action	BDS Table	BDS Object
Create	Create a BDS Table	Create/Update a BDS Object
Read	Read Table Header Objects or Metadata	Read BDS Objects
Delete	Delete a BDS Object	Delete a BDS Object

RBFS Authorization CLI Configurations

Global user role configuration:

> **set system authorization global role** <name> **rbac-permission** <resource-type> <resource-regex> **permission** <permission-map>

role	Represents role in the system
resource_type	Represents resources in the RBFS (table/object).
resource_regex	Regex for the resources to be accessed.
permission	Bitmap representing permissions to create, read and delete. -/-/- -/-/delete -/read/- -/read/delete create/-/- create/-/delete create/read/- create/read/delete

Example

```
admin@rtbick: cfg> set system authorization global role admin rbac-permission
table global.* permission create/read/delete
```

Lawful user role configuration

set system authorization lawful role <name> **rbac-permission** <resource-type> <resource-regex> **permission** <permission>

role	Represents lawful interceptor (LI) role in the system
resource_type	Represents resources in the RBFS (table/object).
resource_regex	Regex for the resources to be accessed.
permission	Bitmap representing permissions to create, read and delete. -/-/- -/-/delete -/read/- -/read/delete create/-/- create/-/delete create/read/- create/read/delete

Example

```
admin@rtbick: cfg> set system authorization lawful role fbi rbac-permission table
local.* permission -/read/-
```

9.1.4. SSH with TACACS+

RBFS provides a custom pluggable authentication module that gets invoked by the stock sshd on login. The necessary configurations are pre-installed on RBFS.

RtBrick-PAM, referred to as RTB-PAM helps in landing the TACACS authentication on the appropriate user in the Ubuntu container and helps in providing necessary details for the secure management plane feature.

Once the PAM client requests TACACS for the authentication, with successful authentication TACACS responds with a few RtBrick specific details.

```
{
     rtb-deny-cmds: “clear bgp peer”
     priv_lvl : some_level
}
```

On successful authentication, the RTB-PAM module creates a token (JWT) for the logged-in ssh user.

RTB-PAM Token

Token created by the RTB-PAM module contains the same claims that are defined under the RtBrick Token section, and this token is signed with the secret_jwks.json key.

The scope claim in the rtb-token is derived from the Linux groups that the locally mapped user belongs to.

The deny commands are converted into the claim rtb-deny-cmds. Once the token is created, it is transferred to the environment variable.

```
setenv RTB_TOKEN = {
  "sub": "83692",
  "iat": 1516239022,
  "exp": 1517239022,
  "name": "Admin User",
  "preferred_username", "user1",
  "scope": "operator tacacs_priv_lvl_8"
  "rtb-deny-cmds": "^clear bgp peer"
}
```

After the RTB-PAM token is created, the CLI prompt appears. If a token is not created for the logged-in user, then the user cannot perform communication with

the BD.

SSH User Prompt

After you successfully log into RBFS via SSH, you can see the rtb-token using the shell environment. For example, an SSH prompt may look like the example below.

```
rtbng@b908f71f63b7:~$ env
SSH_CONNECTION=198.51.100.1 33136 198.51.100.44 22
LESSCLOSE=/usr/bin/lesspipe %s %s
LANG=C.UTF-8
USER=rtbng
PWD=/home/tacacs12
HOME=/home/tacacs12
SSH_CLIENT=198.51.100.1 33136 22
SUDO_USER=rtbng
PRIV_LVL=1
SSH_TTY=/dev/pts/1
SUDO_PROMPT=[sudo] password for rtbng:
MAIL=/var/mail/rtbng
TERM=xterm-256color
SHELL=/bin/bash
SHLVL=1
LOGNAME=rtbng
PATH=/usr/local/sbin:/usr/local/bin:/usr/sbin:/usr/bin:/sbin:/bin:/usr/games:/usr/
local/games
LESSOPEN=| /usr/bin/lesspipe %s
_=/usr/bin/env
RTB_TOKEN=eyJhbGciOiJIUzI1NiIsImtpZCI6InJ0YnJpY2siLCJ0eXAiOiJKV1QifQ.eyJleHAiOjE0N
TE2MDczMDAsImlhdCI6MTQ1MTYwNjQwMCwiaXNzIjoicnRicmljay1hcGktZ3ciLCJuYW1lIjoiQmhpc2h
tYSBBY2hhcnlhIiwicHJlZmVycmVkX3VzZXJuYW1lIjoiYmhpc2htYSIsInNjb3BlIjoic3lzdGVtIiwic
3ViIjoiOTllOGI0YTEtM2E2Yi00YzI5LWJlZGItN2U3N2NjOTFjZTZiIn0.NOOAcafmHfgx-QFwiC-
_VGokbvUwrTOjhfpD9px3hMY
```



The users having access to the Linux shell only can see the installed rtb-token in the shell environment.

User Login Flow

The figure below shows the user login flow.

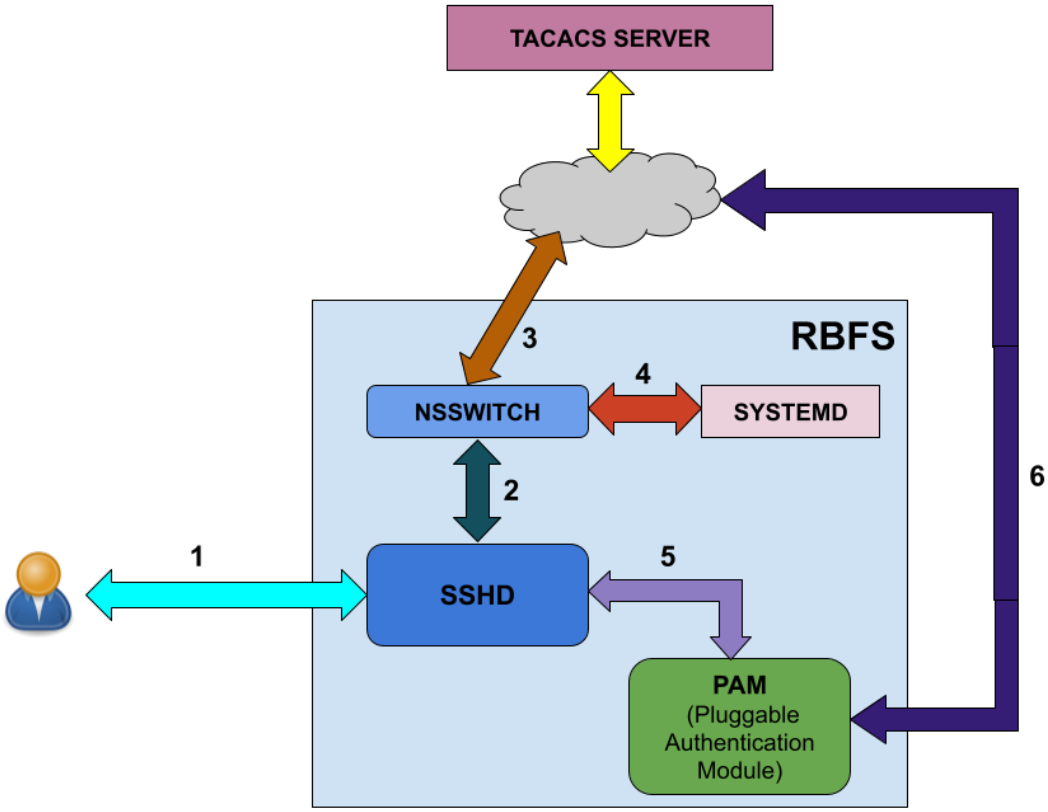


Figure 153. User Login Flow

As shown in the figure above, the following steps are involved in the user login flow.

1. User starts to initialize using ssh
2. The SSH daemon (sshd) refers to the Name Service Switch (NSSWITCH) for user lookup
3. NSSWITCH performs a user lookup at the TACACS server

> A user lookup happens at TACACS user database even for the local users, except for the user 'supervisor'.

4. If the user is not found at TACACS user database, then the user look up happens at the local user database.
5. User authentication is performed by PAM modules
6. PAM communicates to the TACACS server for authentication if it is a TACACS user

Linux pre-configured users and groups

User Name	Group Name	Privilege
supervisor	supervisor	level 15
operator	operator	level 7-14
reader	reader	level 0-6

In-Band and Out-of-Band TACACS user SSH Login

In-band TACACS user SSH Login

A TACACS user can login using SSH to rtbrick container through inband management. RBFS should be configured with inband-management TACACS server for TACACS user login, and inband management configuration should be enabled with TACACS service.

Out-of-band TACACS user SSH Login

TACACS user can login via SSH to RtBrick Host though out-of-band management. RBFS should be configured with out-of-band management TACACS server for TACACS user login.

Configuring TACACS+ for RBFS

To configure TACACS+ server for RBFS, enter the the following commands.

Syntax

set system authorization tacacs <ipv4-address> <attribute> <value>

Command Arguments

Attribute	Description
<ipv4-address>	IPv4 address of the TACACS+ Server.
<inband | out-of-band>	Specifies inband or out-of-band connectivity to the TACACS+ server.

Attribute	Description
<inband | out-of-band> port	Specifies the TACACS+ server's port.
<inband | out-of-band> secret-encrypted-text <secret-encrypted-text>	Specifies the TACACS+ shared secret (encryption) key with a length of 4 to 16419 characters.
<inband | out-of-band> secret-plain-text <secret-plain-text>	Specifies the TACACS+ secret (encryption) key in plain text format with a . Specifies the TACACS+ global passkey in plaintext format with a length of 1 to 240 characters.



For TACACS login to work with inband management, inband configuration must be enabled with the following command: **set inband-management instance** <instance-name> **tacacs true**

Example

```
root@rtbrick: cfg> set system secure-management-status true
root@rtbrick: cfg> set system authorization tacacs 192.0.2.130 inband secret-
plain-text RtBrick_Little_Secret
root@rtbrick: cfg> set inband-management instance inband_mgmt tacacs true
```



A TACACS user is not allowed to login without TACACS+ server configuration.

The example below shows the running configuration after you configure TACACS+.

```
{
  "rtbrick-config:system": {
    "authorization": {
      "tacacs": [
        {
          "ipv4-address": "192.0.2.130",
          "type": "inband",
          "secret-plain-text": "RtBrick_Little_Secret"
        }
      ]
    }
  }
}
```

Example: TACACS User Configuration in the TACACS Server

The example below shows the server configurations for rtb-deny-cmds.



To collect debug information, the linux-group="debug_info,rtbrick_confd_sock_access option should be specified.

```
accounting file = /var/log/tac_plus.acct
key = tacacskey

user = bob {
    login = cleartext "bob"
    member = Network_Operator
}
group = Network_Operator {
  default service = permit
  service = exec {
        priv-lvl = 10
        rtb-deny-cmds = "show bgp.*"
      linux-groups = "debug_info,rtbrick_confd_sock_access"
  }
}
```



The priv-lvl is a mandatory attribute in the TACACS user configuration. The priv-lvl from 0 to 14 always initiate with "/usr/local/bin/cli" and priv-lvl 15 starts with the Linux shell "/bin/bash".

Multiple cmd-regexes can be configured with each regexes separated by semicolon (;).

Example:

```
rtb-deny-cmds = "show bgp .*;show isis .*"
```

Troubleshooting NSS User Lookup Issues

To look up the TACACS username with all NSS methods, enter the following command:

```
ubuntu@rtbrick:~$ sudo getent passwd <tac_user>
```

To look up the local user within the local user database, enter the following command:

```
ubuntu@rtbrick:~$ sudo getent -s compat passwd <local_user>
```

To look up the TACACS user within the TACACS+ server database, enter the following command:

```
ubuntu@batman:~/development$ sudo getent -s tacplus passwd <tacuser>
```

If TACACS does not appear to be working correctly, You can enable debug logging by adding the debug=1 parameter to one or more of these files:

```
/etc/tacplus_servers
/etc/tacplus_nss.con
```

Configuring Secure Management Logs

SSH User Login Logs

The transaction logs of users (in the PAM module) are available in the following log file:

```
/var/log/auth.log
```

Commands to enable secure-management logging:

set log bd <bd_name> **module secure_management logmap** <log_map> **level** <log-level>

Example:

```
root@rtbrick: cfg> set log bd all module secure_management logmap all level Info
```

9.2. Securing Control Plane

9.2.1. Securing the Control Plane Overview

Control plane security is essential for ensuring the reliable operation of a router by controlling the flow of traffic directed from the forwarding plane to the control

plane. This protection is achieved primarily through filtering or rate-limiting mechanisms that prevent unwanted or potentially harmful traffic from overwhelming the router's control functions. In RBFS, the control plane is secured by using Access Control Lists (ACLs) and policers, which are implemented and enforced on the forwarding plane. These ACLs and policers allow precise control over which packets are allowed to reach the control plane and at what rate, effectively safeguarding essential router processes from excessive load or attacks.

Furthermore, control plane security includes the capability to mark traffic generated by the control plane itself. This traffic marking facilitates prioritization within the network, enabling Quality of Service (QoS) benefits and allowing other network devices to identify and apply appropriate filtering or handling policies.

By combining filtering, rate-limiting, and traffic marking, RBFS provides a comprehensive framework to maintain the integrity, stability, and performance of the router's control plane in complex network environments.

Control Plane Traffic

The control plane handles all routing, access, and management protocols. It processes information and configures it into the forwarding plane. For example, routes learned via protocols such as BGP and chosen by the route resolver are programmed into the forwarding plane.

An exception is the management protocols running on the out-of-band management port (typically named me0), which is directly linked to the control plane. Traffic received on this interface does not traverse the forwarding plane and thus is not protected by control plane security mechanisms. This separation ensures no forwarding between forwarding plane interfaces and the out-of-band management interface in the control plane.

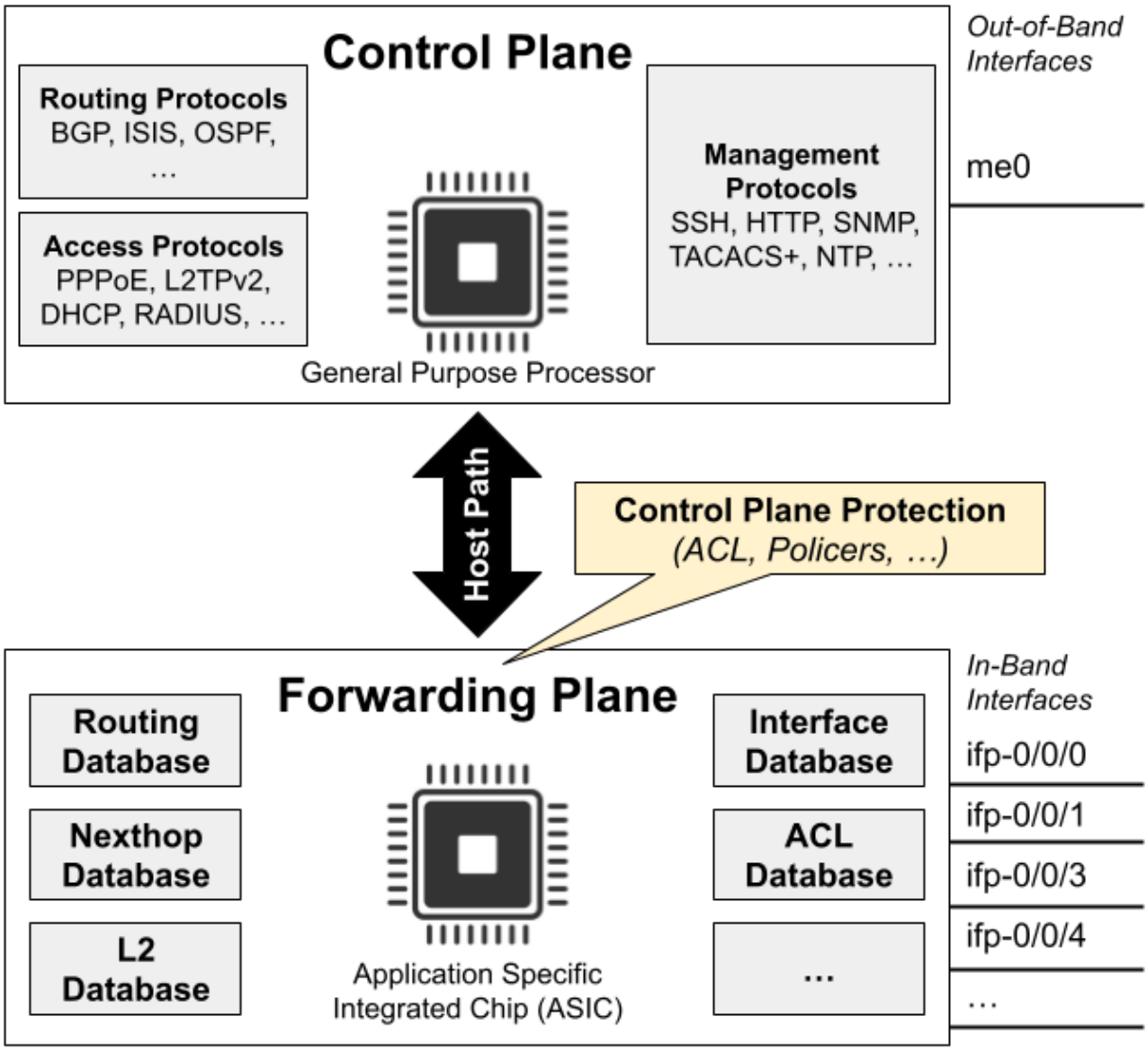


Figure 154. Control Plane Traffic

The diagram shows routing protocols (BGP, ISIS, OSPF), management protocols (SSH, HTTP, SNMP, TACACS+, NTP), and access protocols (PPPoE, L2TPv2, DHCP, RADIUS) associated with the control plane. The control plane uses general-purpose processors and builds databases like forwarding and ACL tables.

Conversely, the forwarding plane uses copies of these tables to make packet flow decisions based on match-action entries. The forwarding plane is implemented with high-performance ASICs capable of handling very high packet rates.

There are two kinds of traffic:

1. **Control Traffic**: Packets destined to the device itself, processed by the router CPU. These are identified by matching destination address, ACL rules, or exceptions (e.g. invalid fields, packet size, TTL).

2. **Transit Traffic**: Packets passing through the router, not destined to it, are forwarded via physical interfaces.

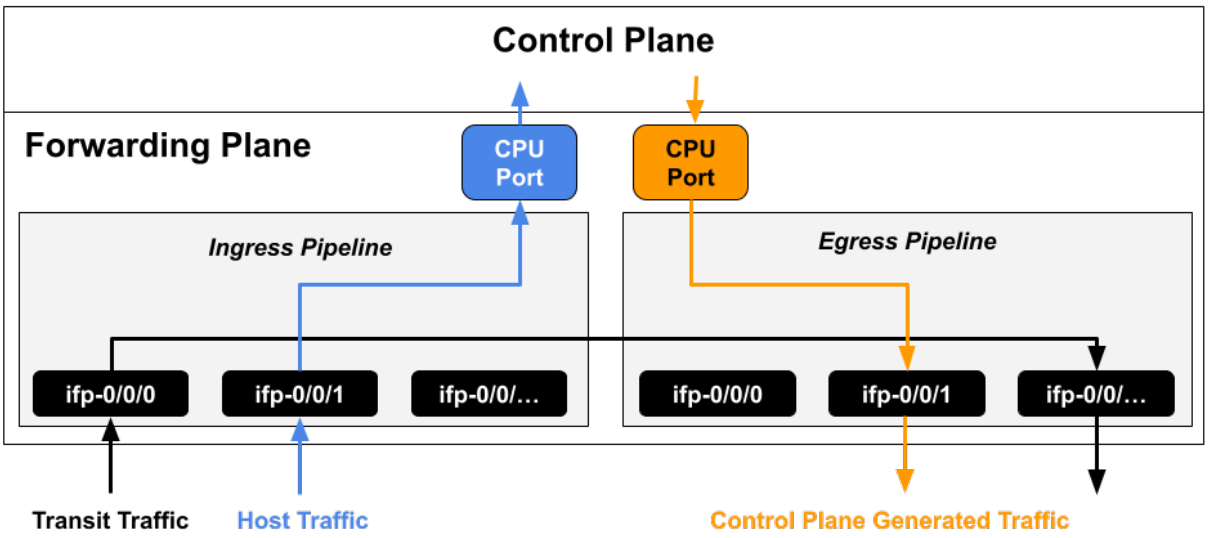


Figure 155. Traffic Types

All control traffic is directed to CPU ports for processing by the control plane. Because general-purpose processors are not optimized for high packet rates, excessive control plane traffic (e.g. from an attacker) can overwhelm the router. Hence, controlling, filtering, and rate-limiting unwanted control-plane traffic is essential for protection.

Securing the Control Plane

In RBFS, control-plane traffic can be redirected to the CPU by three main mechanisms:

1. via ACLs
2. via route lookup
3. via exception (e.g. packet size, TTL)

All those mechanisms need to be considered and secured separately, as described in the following sections.

Control Plane Traffic via Protocol ACLs

Control plane security is built upon automatically generated Access Control Lists (ACLs) for enabled routing, management, and access protocols. These protocol ACLs direct their respective traffic to the control plane. Each ACL rule specifies

match criteria and corresponding actions, such as redirecting traffic to the CPU and applying policers, when a packet matches.



Such protocol ACLs are also sometimes referred to as Trap.

Protocol ACLs:

1. auto-generated
2. specific (e.g. match IPv6 link-local neighbors)
3. high priority of 50 (lower values have priority over higher values)
4. can be verified with show acl command
5. do not require manual configuration

Example 1: Protocol ACL created by BGP

```
supervisor@rtbrick: op> show acl detail
<...>
Rule: default_bgp_l4_trap_192.0.2.101_192.0.2.102_dst
  ACL type: l3v4
  Ordinal: -              Priority: 50
    Match:
      Direction: ingress
      Destination IPv4 address: 192.0.2.102
      Source IPv4 address: 192.0.2.101
      Destination L4 port: 179
      IP protocol: tcp
    Action:
      Redirect to CPU: True
      Policer profile name: _DEFAULT_POLICER_50_MB
    Result:
      Trap ID: bgp
      ACL Handle: 268
<...>
```

The default policer, _DEFAULT_POLICER_50_MB, restricts traffic on these ACLs to 50 Mbps. This bandwidth is shared across all protocols that reference this policer. While almost all protocols share the same policer by default, it is possible to configure dedicated policers for individual protocols or groups of protocols as described in the Control Plane Security Configuration section.

Support for Per-Protocol Control Plane Security Policers

RBFS provides control plane security policers for each protocol. It assigns a dedicated policer to each protocol. Protocols such as LLDP, IS-IS, and PPPoE rely on a independent control plane security policer. Each protocol receives its own

default policer, ensuring fair resource allocation.

The following list provides newly added policers per protocol.

```
_DEFAULT_POLICER_LLDP_GLOBAL_10MB
_DEFAULT_POLICER_ARP_GLOBAL_10MB
_DEFAULT_POLICER_OAM_GLOBAL_20MB
_DEFAULT_POLICER_LDP_GLOBAL_50MB
_DEFAULT_POLICER_PPPOE_GLOBAL_50MB
_DEFAULT_POLICER_OSPF_GLOBAL_50MB
_DEFAULT_POLICER_ISIS_GLOBAL_50MB
_DEFAULT_POLICER_BGP_GLOBAL_100MB
```

Control Plane Traffic via Route Lookup

By default, traffic sent to a router's IP address (referred to as "my IP") that lacks an existing Access Control List (ACL) will be forwarded to the CPU via route lookup. This behavior applies to IP addresses configured on any interface, including loopback interfaces. To protect the control plane from malicious traffic targeting these IP addresses, user-defined ACL rules must be configured in RFBS. These are ACLs that are manually created by the user.

Configuring such ACLs to protect "my IP" is described in the Control Plane Security Configuration section.

Policer Support for TTL=1 Trap Packets

RBFS supports rate limiting for TTL=1 traffic handled by the control plane to prevent control plane overloading. By default, this feature is enabled with a default rate of 10Mbps.

Limitations and Notes

The control-plane security features are supported on hardware platforms only. They are not supported on virtual deployments.

Supported Platforms

Not all features are necessarily supported on each hardware platform. Refer to the *Platform Guide* for the features and the sub-features that are or are not supported by each platform.

9.2.2. Control Plane Security Configuration

Secure Control Plane Traffic via Protocol ACLs

This section details the configuration options for control plane traffic that is redirected to the CPU using protocol ACLs. These ACLs are generated automatically by the protocols and do not require, nor can they be, manually configured. For instance, configuring a routing protocol such as BGP automatically creates the necessary ACLs to match BGP packets and forward them to the control plane.

Configuring the Control Plane Security Feature

Control plane security is active by default, utilizing the _DEFAULT_POLICER_50_MB to cap traffic across most of the protocol ACLs at 50 Mbps. This bandwidth is shared among all protocols using this policer. While protocols share a single policer by default, separate policers can be configured for specific protocols or groups.

Although enabled by default, control plane security can be deactivated, allowing all control plane traffic to be sent to the CPU without any rate limits.

```
set forwarding-options control-plane-security state disable
```



Disabling control-plane security is not recommended.

Configuring Protocol ACL Options

This section describes how to configure policers per protocol and configure a match on IPv4 ToS or IPv6 TC fields for protocol ACLs.

Syntax:

set forwarding-options control-plane-security protocol <protocol-name> <attribute> <value>

Option	Description
protocol <protocol-name>	Name of the protocol. You can configure individual protocols or all protocols using the 'all' keyword. The protocol-specific configurations will take priority over 'all' configuration.
match-tc <tc-value>	Configure IPv6 TC value. The range is 0 to 254.
match-tos <tos-value>	Configure IPv4 ToS value. The range is 0 to 254.
policer <policer>	Configure the policer name.

While all protocols share the same policer by default, it is possible to configure dedicated policers for individual protocols or groups of protocols. Protocols referencing the same policer identified by name will share the same bandwidth limit. If you require separate policers for individual protocols or groups of protocols, even with identical rates, you must assign each a unique name.

Example policer configuration for BGP with 100 Mbps:

```
set forwarding-options class-of-service policer bgp-global
set forwarding-options class-of-service policer bgp-global flags color-blind
set forwarding-options class-of-service policer bgp-global level1-rates cir 100000
set forwarding-options class-of-service policer bgp-global level1-rates cbs 10000
set forwarding-options class-of-service policer bgp-global level1-rates pir 100000
set forwarding-options class-of-service policer bgp-global level1-rates pbs 10000
set forwarding-options class-of-service policer bgp-global levels 1
set forwarding-options class-of-service policer bgp-global type two-rate-three-color
set forwarding-options class-of-service policer bgp-global mode single-level
```

Assign the policer to BGP protocol ACL:

```
set forwarding-options control-plane-security protocol bgp policer bgp-global
```

Other protocols can be similarly protected by either assigning a dedicated policer to each protocol or grouping several protocols under a single policer. We recommend a maximum of 200 Mbps for any single policer, a value that might only be necessary for BGP on certain peering routers. For all other protocols, up to 50 Mbps is typically sufficient.

To enhance system protection, the match-tos and match-tc options can be used to filter protocol traffic, ensuring only correctly marked packets are processed. This adds a layer of security by assuming an attacker would be unable to send traffic with these specific markings.

```
# accept BGP only with TOS 192
set forwarding-options control-plane-security protocol bgp match-tc 192
# send BGP with TOS 192
set forwarding-options class-of-service control-plane-qos outbound-marking protocol bgp tos codepoint 192
```

Secure Control Plane Traffic via Route Lookup

This section details the configuration for control plane traffic that is redirected to the CPU via route lookup, which refers to traffic sent to a router's IP address (referred to as "my IP") that lacks an existing Access Control List (ACL). This behavior applies to IP addresses configured on any interface, including loopback interfaces. By default, this type of traffic is neither restricted nor rate-limited.

Configuring ACLs

In RFBS, ACLs are applied globally and do not require explicit attachment. Rule names serve as configuration handles and do not need to be referenced. However, it is advisable to use distinct rule names for different topics, as counter names are derived from them. For example, use "myip-icmp" and "myip-icmpv6" for rules with dedicated counters.

To secure the control plane, you must apply ACLs and policers through configuration. You do not need to account for protocol traffic already handled by automatically generated protocol ACLs. Instead, you only need to define rules for other traffic sent to "my IP." In the simplest scenario, you can deny all other traffic. Typically, however, you will want to allow specific additional traffic, such as ICMP with a rate limit, while denying everything else. Alternatively, you could allow all traffic but apply a small policer rate.

Syntax:

set forwarding-options acl <options>

Option	Description
l3v4	ACL configuration for IPv4
l3v6	ACL configuration for IPv6
rule <rule-name>	Name of the ACL rule

Option	Description
ordinal <ordinal-value>	Number of the configuration entry. Please note that the order of the configuration entries (ordinals) does not determine the processing.
match <condition>	Set match conditions such as source and destination prefixes, prefix lists, ports, and protocols. When multiple match conditions are specified within the same ordinal, they are combined as a logical AND, meaning all conditions must be met.
action <action>	Set action like permit, drop, or policer-name.
priority <value>	Configure the ACL entry priority. Lower values take precedence, with the default set to 500. RBFS utilizes TCAM-based ACLs to enable parallel evaluation of all rules, which allows for high-speed processing and efficient matching. When multiple rules match a given packet, the highest priority rule (lowest value) is applied.

RBFS supports the match conditions destination-ipv4-local and destination-ipv6-local. These options are converted internally into a prefix list that includes all interface addresses. As a result, any rule using these match options is installed multiple times, once for each interface address.

The following rule is an example rule that drops all traffic with a destination one of the router IP addresses, but since the priority of 2000 is higher than the protocol priority of 50, the protocol traffic, like BGP, is not dropped, since the BGP protocol rule also matches and is prioritized.

```
set forwarding-options acl l3v4 rule myip-discard
set forwarding-options acl l3v4 rule myip-discard ordinal 2000
set forwarding-options acl l3v4 rule myip-discard ordinal 2000 match direction ingress
set forwarding-options acl l3v4 rule myip-discard ordinal 2000 match destination-ipv4-local true
set forwarding-options acl l3v4 rule myip-discard ordinal 2000 action drop true
set forwarding-options acl l3v4 rule myip-discard ordinal 2000 action statistics true
set forwarding-options acl l3v4 rule myip-discard ordinal 2000 priority 2000
```

When designing security ACLs to protect "my IP", you may don’t want to completely block all unwanted traffic. Instead, you might allow and rate-limit specific necessary traffic, such as ICMP. It’s important to remember that you do not need to consider protocol traffic already handled by the protocol ACL when creating

these security ACLs.

In environments with thousands of logical interfaces and multiple rules, an alternative approach to reduce ACL usage could be employing custom prefix lists with aggregate prefixes of interface addresses or other match criteria. This is why these ACLs are not automatically generated, as each environment is unique and may require different rules. The configuration section provides common best practices that are applicable to many networks or can serve as a foundation for modifications based on specific requirements.

Restricting In-Band Management Access

Enabling in-band management, such as SSH, automatically creates protocol ACLs. These ACLs are configured to match the enabled protocols, directing management traffic to the control plane. By default, this traffic is not restricted by source IP addresses. To further enhance security, in-band management access can be restricted to trusted IP addresses by applying a source prefix list, which adds an extra match condition to the in-band management protocol ACLs.



This prefix list must contain /32 only! Any other prefix length is not supported!

```
set forwarding-options prefix-list trusted-ssh ipv4-prefix 10.10.10.1/32
set forwarding-options prefix-list trusted-ssh ipv4-prefix 10.10.10.2/32

set inband-management instance default ssh true
set inband-management instance default source-prefix-list trusted-ssh
```

By default, in-band management traffic is limited by control-plane-security to 20 Mbps using the _DEFAULT_POLICER_20_MB policer. This policer can be changed as previously explained using the protocol inband, as well in-band can also be optionally limited to only match if a given tos/tc marking is set.

```
set forwarding-options class-of-service policer inband-global flags color-blind
set forwarding-options class-of-service policer inband-global level1-rates
set forwarding-options class-of-service policer inband-global level1-rates cir 100000
set forwarding-options class-of-service policer inband-global level1-rates cbs 10000
set forwarding-options class-of-service policer inband-global level1-rates pir 100000
set forwarding-options class-of-service policer inband-global level1-rates pbs 10000
set forwarding-options class-of-service policer inband-global levels 1
set forwarding-options class-of-service policer inband-global type two-rate-three-color
set forwarding-options class-of-service policer inband-global mode single-level

set forwarding-options control-plane-security protocol inband policer inband-global
set forwarding-options control-plane-security protocol inband match-tos 128
```

Marking Outbound Control Plane Traffic

RBFS offers a flexible configuration of TOS, TC, or VLAN P-BIT markings for outbound control plane traffic.

These settings can be applied per protocol and, in some cases, individually per interface. While both Layer 2 (P-BIT) and Layer 3 (TOS) markings are configurable for all protocols, support for each marking type may vary, with some protocols supporting only one and others supporting both.

Supported QoS types and IFP support

Protocol	Markings	IFP-based	IFL-based
l2-all	p-bit	NO	NO
l3-all	tos	NO	NO
BGP	tos	NO	YES
OSPF	tos	NO	YES
LDP	tos	NO	YES
ISIS	p-bit	NO	YES
PIM	tos	NO	YES
DHCP Relay	p-bit	NO	YES
RADIUS	tos	NO	YES
IPoE	tos	NO	NO
PPPoE	tos/p-bit	YES(p-bit only)	NO
IGMP	tos/p-bit	YES(p-bit only)	NO
L2TP	tos	NO	YES
ARP/ND	p-bit	NO	YES
CFM	p-bit	NO	NO
MPLS-OAM	tos	NO	NO

Settings are prioritized as follows: IFP/IFL (highest), protocol level, and l2-all/l3-all (lowest). For example, if a user configures the p-bit for both the ARP protocol and "l2-all," the ARP protocol setting takes precedence. If the ARP p-bit is then removed, the "l2-all" configuration will be applied.



Redundancy-related control traffic can be marked with a specific

> tos value with the L3-all option.

Example:

```
set forwarding-options class-of-service control-plane-qos outbound-marking protocol arp p-bit codepoint 6
set forwarding-options class-of-service control-plane-qos outbound-marking protocol arp p-bit ifl ifl-0/0/0/0
codepoint 5

set forwarding-options class-of-service control-plane-qos outbound-marking protocol l3-all tos codepoint 128

set forwarding-options class-of-service control-plane-qos outbound-marking protocol radius tos codepoint 192

set forwarding-options class-of-service control-plane-qos outbound-marking protocol ppp p-bit codepoint 6
set forwarding-options class-of-service control-plane-qos outbound-marking protocol ppp tos codepoint 192
```

The command show qos control-plane displays QoS remarking types, interface names, and codepoints for all or specified protocols.

```
op> show qos control-plane protocol ppp
Protocol        Remark Type       Interface         Codepoint
ppp             p-bit                  all             5
                                    ifp-0/0/1          3
                                    ifp-0/0/2          4
```

Reference Configurations

My-IP Discard

The following example demonstrates a basic configuration that should be suitable for many setups. It allows ICMP traffic but limits it to 10 Mbps using dedicated policers for ICMPv4 and ICMPv6. All other traffic not previously accepted by any protocol ACL is then discarded. If ICMP is not required, these rules can be removed.

```
set forwarding-options acl l3v4 rule myip-icmp ordinal 1500 match direction ingress
set forwarding-options acl l3v4 rule myip-icmp ordinal 1500 match ip-protocol icmp
set forwarding-options acl l3v4 rule myip-icmp ordinal 1500 match destination-ipv4-local true
set forwarding-options acl l3v4 rule myip-icmp ordinal 1500 action policer-name icmp-global
set forwarding-options acl l3v4 rule myip-icmp ordinal 1500 priority 1500

set forwarding-options acl l3v4 rule myip-discard ordinal 2000 match direction ingress
set forwarding-options acl l3v4 rule myip-discard ordinal 2000 match destination-ipv4-local true
set forwarding-options acl l3v4 rule myip-discard ordinal 2000 action drop true
set forwarding-options acl l3v4 rule myip-discard ordinal 2000 action statistics true
set forwarding-options acl l3v4 rule myip-discard ordinal 2000 priority 2000

set forwarding-options acl l3v6 rule myipv6-icmpv6 ordinal 1500 match direction ingress
set forwarding-options acl l3v6 rule myipv6-icmpv6 ordinal 1500 match ip-protocol ipv6_icmp
set forwarding-options acl l3v6 rule myipv6-icmpv6 ordinal 1500 match destination-ipv6-local true
set forwarding-options acl l3v6 rule myipv6-icmpv6 ordinal 1500 action policer-name icmpv6-global
set forwarding-options acl l3v6 rule myipv6-icmpv6 ordinal 1500 priority 1500

set forwarding-options acl l3v6 rule myipv6-discard ordinal 2000 match direction ingress
```

```
set forwarding-options acl l3v6 rule myipv6-discard ordinal 2000 match destination-ipv6-local true
set forwarding-options acl l3v6 rule myipv6-discard ordinal 2000 action drop true
set forwarding-options acl l3v6 rule myipv6-discard ordinal 2000 action statistics true
set forwarding-options acl l3v6 rule myipv6-discard ordinal 2000 priority 2000

set forwarding-options class-of-service policer icmp-global flags color-blind
set forwarding-options class-of-service policer icmp-global level1-rates
set forwarding-options class-of-service policer icmp-global level1-rates cir 10000
set forwarding-options class-of-service policer icmp-global level1-rates cbs 1000
set forwarding-options class-of-service policer icmp-global level1-rates pir 10000
set forwarding-options class-of-service policer icmp-global level1-rates pbs 1000
set forwarding-options class-of-service policer icmp-global levels 1
set forwarding-options class-of-service policer icmp-global type two-rate-three-color
set forwarding-options class-of-service policer icmp-global mode single-level

set forwarding-options class-of-service policer icmpv6-global flags color-blind
set forwarding-options class-of-service policer icmpv6-global level1-rates
set forwarding-options class-of-service policer icmpv6-global level1-rates cir 10000
set forwarding-options class-of-service policer icmpv6-global level1-rates cbs 1000
set forwarding-options class-of-service policer icmpv6-global level1-rates pir 10000
set forwarding-options class-of-service policer icmpv6-global level1-rates pbs 1000
set forwarding-options class-of-service policer icmpv6-global levels 1
set forwarding-options class-of-service policer icmpv6-global type two-rate-three-color
set forwarding-options class-of-service policer icmpv6-global mode single-level
```

Protocol Policers

This example demonstrates the configuration of user-defined policers. BGP traffic is limited to 100 Mbps, while ISIS and PPPoE traffic are each capped at 50 Mbps using dedicated policers.

```
set forwarding-options class-of-service policer bgp-global flags color-blind
set forwarding-options class-of-service policer bgp-global level1-rates
set forwarding-options class-of-service policer bgp-global level1-rates cir 100000
set forwarding-options class-of-service policer bgp-global level1-rates cbs 10000
set forwarding-options class-of-service policer bgp-global level1-rates pir 100000
set forwarding-options class-of-service policer bgp-global level1-rates pbs 10000
set forwarding-options class-of-service policer bgp-global levels 1
set forwarding-options class-of-service policer bgp-global type two-rate-three-color
set forwarding-options class-of-service policer bgp-global mode single-level

set forwarding-options control-plane-security protocol bgp policer bgp-global

set forwarding-options class-of-service policer isis-global flags color-blind
set forwarding-options class-of-service policer isis-global level1-rates
set forwarding-options class-of-service policer isis-global level1-rates cir 50000
set forwarding-options class-of-service policer isis-global level1-rates cbs 5000
set forwarding-options class-of-service policer isis-global level1-rates pir 50000
set forwarding-options class-of-service policer isis-global level1-rates pbs 5000
set forwarding-options class-of-service policer isis-global levels 1
set forwarding-options class-of-service policer isis-global type two-rate-three-color
set forwarding-options class-of-service policer isis-global mode single-level

set forwarding-options control-plane-security protocol isis policer isis-global

set forwarding-options class-of-service policer pppoe-global flags color-blind
set forwarding-options class-of-service policer pppoe-global level1-rates
set forwarding-options class-of-service policer pppoe-global level1-rates cir 50000
set forwarding-options class-of-service policer pppoe-global level1-rates cbs 5000
set forwarding-options class-of-service policer pppoe-global level1-rates pir 50000
set forwarding-options class-of-service policer pppoe-global level1-rates pbs 5000
```

```
set forwarding-options class-of-service policer pppoe-global levels 1
set forwarding-options class-of-service policer pppoe-global type two-rate-three-color
set forwarding-options class-of-service policer pppoe-global mode single-level

set forwarding-options control-plane-security protocol pppoe policer pppoe-global
```

9.2.3. Control Plane Security Operational Commands

Show Commands

This section describes operational commands available to verify various control-plane security features.

Verifying ACLs

The show acl command allows to verify protocol ACLs as well as user-defined ACLs.

Syntax:

show acl <options>

Option	Description
detail	Displays all ACL details
<acl-name>	Displays the details for a single ACL

Example 1: Protocol ACL with Control-Plane Security enabled

```
supervisor@rtbrick>: op>  show acl detail

Rule: lldp.ifp-0/0/1.trap.rule
  ACL type: l2
  Ordinal: -
    Match:
      Attachment point: ifp-0/0/1
      Direction: ingress
      Destination MAC: 01:80:c2:00:00:0e
    Action:
      Redirect to CPU: True
      Policer profile name: _DEFAULT_POLICER_50_MB
    Result:
      Trap ID: LLDP
<...>
Rule: radius-srv1-v4-auth-trap
  ACL type: l3v4
  Ordinal: -
    Match:
```

```
      Source L4 port: 1812
      IP protocol: UDP
    Action:
      Redirect to CPU: True
      Policer profile name: _DEFAULT_POLICER_20_MB
    Result:
      Trap ID: Radius
<...>
```

Example 2: ACL for Inband Management with Source Prefix List

```
supervisor@rtbrick>: op>  show acl detail
<...>
Rule: ifm.inband.mgmt.lo-0/0/0/0.ssh.client.v4.trap.rule.1
  ACL type: l3v4
  Ordinal: 1             Priority: 50
    Match:
      Direction: ingress
      Destination IPv4 address: 192.0.2.1
      Source IPv4 address: 10.10.10.1
      Source L4 port: 22
      IP protocol: tcp
      IP TOS: 64
    Action:
      Redirect to CPU: True
      Policer profile name: inband-global
    Result:
      Trap ID: inband
      ACL Handle: 97
<...>
```

Example 3: User-defined ACL to Protect "my IP"

```
supervisor@rtbrick>: op> show acl rule myip-discard
Rule: myip-discard
  ACL type: l3v4
  Ordinal: 300005        Priority: 2000
    Match:
      Direction: ingress
      Destination IPv4 prefix: 192.0.2.1/32
    Action:
      Stats enabled: True
      Drop: True
    Result:
      Trap ID: user-defined
      ACL Handle: 108
<...>
```

Verifying ACL Counters

The show acl statistics command displays information about the ACL packet counters. The counters are useful to verify if the ACL rules actually match, and if

potentially malicious traffic gets dropped.

Syntax:

```
show acl statistics
```

Example 1: ACL statistics information

```
supervisor@rtbrick>: op> show acl statistics
ACL                                                                  Units      Total
Accepted    Dropped
lldp.ifp-0/0/12.trap.rule                                            Packets    -          -
-
                                                                     Bytes      -          -
-
lldp.ifp-0/0/16.trap.rule                                            Packets    -          -
-
                                                                     Bytes      -          -
-
lldp.ifp-0/0/27.trap.rule                                            Packets    -          -
-
                                                                     Bytes      -          -
-
lldp.ifp-0/0/53.trap.rule                                            Packets    -          -
-
                                                                     Bytes      -          -
-
default_bgp_l4_trap_12::2_12::1_dst                                  Packets    12         12
0
                                                                     Bytes      1353       1353
0
default_bgp_l4_trap_12::2_12::1_src                                  Packets    12         12
0
                                                                     Bytes      1353       1353
0
default_bgp_l4_trap_12.0.0.2_12.0.0.1_dst                            Packets    12         12
0
                                                                     Bytes      1353       1353
0
default_bgp_l4_trap_12.0.0.2_12.0.0.1_dst                            Packets    -          -
-
                                                                     Bytes      -          -
-
default_bgp_l4_trap_12.0.0.2_12.0.0.1_src                            Packets    12         12
0
                                                                     Bytes      1353       1353
0
default_bgp_l4_trap_12.0.0.2_12.0.0.1_src                            Packets    -          -
-
                                                                     Bytes      -          -
-
<...>
```

Example 2: Display ACL statistics information for a specified ACL

```
supervisor@rtbrick>: op> show acl default_bgp_l4_trap_12.0.0.2_12.0.0.1_dst statistics
ACL                                                                  Units      Total
Accepted    Dropped
default_bgp_l4_trap_12.0.0.2_12.0.0.1_dst                            Packets    20         20
0
                                                                     Bytes      1917       1917
0
default_bgp_l4_trap_12.0.0.2_12.0.0.1_dst                            Packets    -          -
```

```
-
                                                                    Bytes      -          -
-
```

Verifying Control Plane Policers

This command allows to view the policers created by the control-plane security feature.

Syntax:

show qos policer <options>

Option	Description
-	Displays all policers, including those created by the control-plane security feature.
<policer-name>	Displays information about a specified policer.
counter	Displays all policer counters.

Example 1: Display information of all policers created by the control-plane security feature.

```
supervisor@rtbrick>: op> show qos policer
Policer: _DEFAULT_POLICER_100_MB
Active: True, Type: two-rate-three-color, Levels: 1, Flags: -
  Level    CIR(Kbps)      PIR(Kbps)      CBS(KB)        PBS(KB)        Max CIR(Kbps)  Max PIR(Kbps)
  1        100000         100000         33000          33000          -              -
  2        -              -              -              -              -              -
  3        -              -              -              -              -              -
  4        -              -              -              -              -              -
Policer: _DEFAULT_POLICER_1_MB
Active: True, Type: two-rate-three-color, Levels: 1, Flags: -
  Level    CIR(Kbps)      PIR(Kbps)      CBS(KB)        PBS(KB)        Max CIR(Kbps)  Max PIR(Kbps)
  1        1000           1000           33000          33000          -              -
  2        -              -              -              -              -              -
  3        -              -              -              -              -              -
  4        -              -              -              -              -              -
Policer: _DEFAULT_POLICER_20_MB
Active: True, Type: two-rate-three-color, Levels: 1, Flags: -
  Level    CIR(Kbps)      PIR(Kbps)      CBS(KB)        PBS(KB)        Max CIR(Kbps)  Max PIR(Kbps)
  1        20000          20000          33000          33000          -              -
  2        -              -              -              -              -              -
  3        -              -              -              -              -              -
  4        -              -              -              -              -              -
Policer: _DEFAULT_POLICER_250_MB
Active: True, Type: two-rate-three-color, Levels: 1, Flags: -
  Level    CIR(Kbps)      PIR(Kbps)      CBS(KB)        PBS(KB)        Max CIR(Kbps)  Max PIR(Kbps)
  1        250000         250000         33000          33000          -              -
  2        -              -              -              -              -              -
  3        -              -              -              -              -              -
  4        -              -              -              -              -              -
```

```
Policer: _DEFAULT_POLICER_500_MB
Active: True, Type: two-rate-three-color, Levels: 1, Flags: -
  Level    CIR(Kbps)      PIR(Kbps)      CBS(KB)        PBS(KB)        Max CIR(Kbps)  Max PIR(Kbps)
  1        500000         500000         33000          33000          -              -
  2        -              -              -              -              -              -
  3        -              -              -              -              -              -
  4        -              -              -              -              -              -
Policer: _DEFAULT_POLICER_50_MB
Active: True, Type: two-rate-three-color, Levels: 1, Flags: -
  Level    CIR(Kbps)      PIR(Kbps)      CBS(KB)        PBS(KB)        Max CIR(Kbps)  Max PIR(Kbps)
  1        50000          50000          33000          33000          -              -
  2        -              -              -              -              -              -
  3        -              -              -              -              -              -
  4        -              -              -              -              -              -
Policer: _DEFAULT_POLICER_5_MB
Active: True, Type: two-rate-three-color, Levels: 1, Flags: -
  Level    CIR(Kbps)      PIR(Kbps)      CBS(KB)        PBS(KB)        Max CIR(Kbps)  Max PIR(Kbps)
  1        5000           5000           33000          33000          -              -
  2        -              -              -              -              -              -
  3        -              -              -              -              -              -
  4        -              -              -              -              -              -
```

Example 2: Display information of a specific policer

```
supervisor@rtbrick>: op> show qos policer _DEFAULT_POLICER_50_MB
Policer: _DEFAULT_POLICER_50_MB
Type: two-rate-three-color, Levels: 1, Flags: -
  Level    CIR(Kbps)      PIR(Kbps)      CBS(Kbits)     PBS(Kbits)     Max CIR(Kbps)  Max PIR(Kbps)
  1        50000          50000          33000          33000          -              -
  2        -              -              -              -              -              -
  3        -              -              -              -              -              -
  4        -              -              -              -              -              -
```

Example 3: Display policer counters

```
supervisor@rtbrick>: op> show qos policer counter
Interface                          Level  Units      Total            Received         Dropped
ipv6_ll_prefix_acl                 1      Packets    48               48               0
                                          Bytes      6383             6383             0
ipv6_mcast_ff01_prefix_acl         1      Packets    48               48               0
                                          Bytes      6383             6383             0
ipv6_mcast_ff02_prefix_acl         1      Packets    48               48               0
                                          Bytes      6383             6383             0
pppoed_ifp-0/1/28_1-3500-1-35      1      Packets    48               48               0
                                          Bytes      6383             6383             0
pppoed_ifp-0/1/28_1-3500-1-35      1      Packets    48               48               0
                                          Bytes      6383             6383             0
pppoed_ifp-0/1/30_1-3500-1-35      1      Packets    48               48               0
                                          Bytes      6383             6383             0
pppoed_ifp-0/1/30_1-3500-1-35      1      Packets    48               48               0
                                          Bytes      6383             6383             0
<...>
```



This view displays multiple rules, such as the four PPPoE rules, all referencing the same policer. This shared reference explains why they exhibit identical counter values, as they point to a single policer instance.

Example 4: Display trap statistics

```
supervisor@rtbrick>: op> show trap statistics
Trap Statistics Type: rpf
    Statistics ID: 1
    Counters:
        Forward-Packets: 0
        Forward-Bytes: 0
        Drop-Packets: 0
        Drop-Bytes: 0
Trap Statistics Type: mtu_irpp
    Statistics ID: 2
    Counters:
        Forward-Packets: 0
        Forward-Bytes: 0
        Drop-Packets: 0
        Drop-Bytes: 0
Trap Statistics Type: ttl1
    Statistics ID: 3
    Counters:
        Forward-Packets: 0
        Forward-Bytes: 0
        Drop-Packets: 0
        Drop-Bytes: 0
Trap Statistics Type: dhcp
    Statistics ID: 4
    Counters:
        Forward-Packets: 0
        Forward-Bytes: 0
        Drop-Packets: 0
        Drop-Bytes: 0
Trap Statistics Type: mpls_unknown_label
    Statistics ID: 6
    Counters:
        Forward-Packets: 0
        Forward-Bytes: 0
        Drop-Packets: 0
        Drop-Bytes: 0
```

9.3. Local User Management

9.3.1. Local User Management Overview

Local User Management enables you to create, manage, and secure the Linux local users and groups through the RBFS configuration. This enables you to manage users and groups in the following environments:

- In the RBFS container only for the virtual platform
- In the RBFS container and on the RtBrick Host for the hardware platforms

Supported Platforms

Not all features are necessarily supported on each hardware platform. Refer to the *Platform Guide* for the features and the sub-features that are or are not supported by each platform.

9.3.2. Local user management Configuration

RBFS allows you to create privileges that are configurable for user-defined and pre-defined roles. RBFS supports a combination of permit and deny regular expressions and a configurable default privilege to support both blacklisting and whitelisting of users. If both permit and deny command regular expressions match, the allow regular expression takes precedence.

Creating Roles

To create a role, you need to configure the following:

- Configure role-based access control (RBAC) privilege for the role
- Configure the command privilege for the role



It is important to have secure management enabled when granting any type of privilege, whether it is RBAC or command-based, to any user. Without secure management, privileges do not work.

For information about enabling Secure Management, see the section "Configuring Secure Management Logs" of the *Securing Management Plane* user guide.

Configuring the RBAC Privilege

You need to configure the RBAC privilege for both table and object.

set system authorization global role <name> **rbac-permission** (**object** | **table**) <resource> <permission-type>

Command arguments

<name>	Authorization role name

<resource>	Represents resources in the RBFS (table/object)
<permission-type>	Permissions to create, read and delete. The following are the supported RBAC permission types: -/-/- -/-/delete -/read/- -/read/delete create/-/- create/-/delete create/read/- create/read/delete

Configuring the Command Privilege

set system authorization global role <name> **cmd-permission** (**allow-cmds** <allow-cmds> | **deny-cmds** <deny-cmds>)

<role>	Authorization role name
<allow-cmds>	List of allow commands regular expression
<deny-cmds>	List of deny commands regular expression



- If you configure a privilege for any of the pre-defined roles (supervisor, operator, reader), then it replaces the default privilege.
- If you delete the configured privilege for a pre-defined role, then it will revert to the default privilege of the role.
- Priority of privilege rules is as follows: explicit deny, explicit permit, default privilege.

The example below shows the new role named "support" which has RBAC permission to read any table and objects. Also, the user is denied everything except the allowed commands (ping, set, show, traceroute, and watch-mode).

```
{
  "ietf-restconf:data": {
    "rtbrick-config:system": {
      "authorization": {
        "global": {
```

```
          "role": [
            {
              "name": "support",
              "rbac-permission": [
                {
                  "permission": "-/read/-",
                  "resource-type": "object",
                  "resource": ".*"
                },
                {
                  "permission": "-/read/-",
                  "resource-type": "table",
                  "resource": ".*"
                }
              ],
              "cmd-permission": {
                "allow-cmds": [
                  "ping .*",
                  "set .*",
                  "show .*",
                  "traceroute .*",
                  "watch .*"
                  ],
                "deny-cmds": ".*"
              }
            }
          ]
        }
      }
    }
  }
}
```

Linux pre-configured users, roles and privileges

User Name	Role Name	Default Privileges
supervisor	supervisor	Allow all actions.
operator	operator	Allow all actions except for the "reboot" action.

reader	reader	All commands will be denied other than the commands which match any of the below regular expressions.
		
		`"color.*",`
		`"collect.*",`
		`"date.*",`
		`"exit.*",`
		`"history.*",`
		`"paging.*",`
		`"ping.*",`
		`"show.*",`
		`"traceroute.*",`
		`"watch-mode.*"`

Creating New Users

The new users created through local user management will always have a primary group with the same name and ID of the created user. The new user's ID will be allocated within the range of 3000 and 3999.



You cannot use usernames such as root, wheel, admin, sudo or any of the SMP Linux pre-configured users and groups such as supervisor, operator, reader. Also, a username cannot start with "rtbrick_". If a Linux user with the same username already exists but has an ID outside of the 3000-3999 range then the user creation through the RBFS configuration will fail.

To create a new user, enter the following command:

set system user <username>

Command arguments

<username>	Name of the local user

Assigning Roles to Users

A "role" is an RBFS RBAC construct and it is mapped to a Linux group. The list of user roles from the RBFS configuration becomes the list of additional Linux groups that the Linux user belongs to. You can create new users and assign "roles" to the new users. The supervisor, operator, and reader are the pre-defined and pre-configured roles both in Linux and RBFS.

When a user is configured in RBFS under "system users", RBFS/confd validates that the list of user roles only contain roles that are pre-defined or that are configured under "system authorization".



Do not create role names that start with "rtbrick_". In addition, "root", "wheel", "admin", and "sudo" are not acceptable role names.

To assign a role to a new user, enter the following command:

set system user <username> **role** <role>

Command arguments

<username>	Name of the user
<role>	Role of the user (not the primary role)

Example: Assigning Roles to Users

```
{
  "ietf-restconf:data": {
    "rtbrick-config:system": {
      "user": [
        {
          "username": "bob",
          "role": [
            "operator"
            ],
          "shell": "/usr/local/bin/cli",
          "password-hashed-text":
"$6$uTE4OYn0iRq.Vppe$JBVMQ5DZHfuCuUP5yTnfl9IJsRLQAXqTLlLMKRO8bCz9WDlB2ele8puwMrT4/
QDF2nNOcoHtqYqFljly4B.Vu0"
        }
      ]
    }
  }
}
```

Configuring Authentication for a New User

There are two ways in which you can create a password for a new user in RBFS:

1. Creating hashed password
2. Creating plain-text password

Creating Hashed Password

You can verify the integrity of your password using hashed passwords. When a user is present in the configuration but a "password hashed text" is not present, the password authentication is considered disabled for that specific user.

Three predefined roles include supervisor, operator, and reader. supervisor is the default password for the role supervisor. For the 'operator' and 'reader' roles, there is no default password.

Use the system users supervisor command to disable the default supervisor password.

You can also disable password authentication for any of the predefined users such as supervisor, operator and reader by adding a "system users supervisor" configuration section without any "password hashed text" and thus disabling password authentication for the supervisor user.

SSH public keys can be configured even if "password hashed text" is not present.

To create a password hashed text and authenticate the new user, perform the following steps:

1. Generate hash password on any Linux server.
   mkpasswd --method=SHA-512
2. Configure authentication using a password hashed text and an SSH public key.
   set system user <username> **password-hashed-text** <password-hashed-text>
   set system user <username> **ssh-pub-key** <ssh-pub-key>

Changing an Existing Hashed Password for Supervisor

You can change an existing hashed password for a 'supervisor' user after logging in to the system.

Syntax:

set system user <username> **password-hashed-text** <password-hashed-text>
set system user <username> **ssh-pub-key** <ssh-pub-key>

Example Command:

```
set system user supervisor password-hashed-text
$6$HIPXmd0uiLD0RtcT$3V7YxFJWR3b6NEGGd41RCT0TseWgdKLFAl6RecvDOqIUnaCHMt0zo0ZZR4/1
```

Command arguments

<username>	Name of the user.

<password-hashed-text>	Password string.
<ssh-pub-key>	public keys of a user. You can specify multiple ssh-pub-keys.

3. Log in using username and password hashed text.



- It is possible to change shell, password-hash and ssh-pub-keys for supervisor, reader, and operator roles.
- The password string provided as part of the RBFS configuration needs to be a compatible password hashed text as defined by the shadow manual page: https://manpages.debian.org/buster/passwd/shadow.5.en.html and by the crypt https://manpages.debian.org/buster/manpages-dev/crypt.3.en.html.

Example

```
{
  "ietf-restconf:data": {
    "rtbrick-config:system": {
      "user": [
        {
          "username": "bob",
          "shell": "/usr/local/bin/cli",
          "password-hashed-text":
"$5$L2DaOYYuddhBV$9RA5MX9RQzLC9fIKJzbnoFBb88w9rkSXl7GVrVJ9PY7",
          "ssh-pub-key": [
            "ssh-rsa
AAAAB3NzaC1yc2EAAAADAQCBAAABAQCubg5sdDycPN5EViNkV6w7rfp2GAfKWuInfaL3xOXyvSNpsmaHIL
YmgrLUU0GKQH9gauPUJpDcvvYaMt0ZBuTbWHVMUc4cvhgbNDkTB2bG2cTZ5QzbicyXff3BlDWQThVp2LtV
BiW2tf7JTTa9SnL4Lnm+CQcXsQ0rxqy2S6bJpsRYlFMyQl/hZ4QEWE153dw0HGvcG8mjfnPN4wvCc/omfD
3ljxx+Gf4oFS0davX6pdphUKLvgL33VVG5xaK71imv2l3897LIJZaHxy7FbB+CjSYT6QNq1XksX8omrbRj
iP3enEQi/bANtzTNnGDnIm1KHf3xuKpoKw+B5fhDZogx"
          ]
        }
      ]
    }
  }
}
```

Creating Plain-Text Password

To configure a password with plain text password for a new user, use the following command.

Syntax:

set system user <username> **password-plain-text** <password-plain-text>

Command arguments

<username>	Name of the user
<password-plain-text>	Specifies the plain-text password

Example for Configuring Plain Text Password

```
set system user bob password-plain-text bob123
set system user bob shell /usr/local/bin/cli
set system user bob role operator
```

Changing an Existing Plain-Text Password for Supervisor

You can change an existing plain text password for the 'supervisor' user after logging into the system. Use the following commands to change an existing password.

Syntax:

set system user <username> **password-plain-text** <password-plain-text>

Sample Commands:

```
set system user supervisor shell /bin/bash
set system user supervisor password-plain-text rtbrick
```

Viewing Configuration of Plain Text Password

```
{
  "ietf-restconf:data": {
    "rtbrick-config:system": {
      "user": [
        {
          "username": "bob",
```

```
          "role": [
            "operator"
            ],
          "shell": "/usr/local/bin/cli",
          "password-hashed-text":
"$6$uTE4OYn0iRq.Vppe$JBVMQ5DZHfuCuUP5yTnfl9IJsRLQAXqTLlLMKRO8bCz9WDlB2ele8puwMrT4/
QDF2nNOcoHtqYqFljly4B.Vu0"
        }
      ]
    }
  }
}
```

Setting the User Shell

RBFS validates that the shell is one of the following 3 valid options:

- /usr/sbin/nologin
- /bin/bash
- /usr/local/bin/cli

To configure user shell, enter the following command:

set system user <username> **shell** <shell>

Command arguments

<username>	Name of the user
<shell>	Name of the shell

Example

```
root@rtbrick: cfg> set system user smith shell /usr/local/bin/cli
```

Specifying the Display Name for User Names

The display name allows you to specify a preferred name so that you can easily identify the user. You can change your display name by entering the following command:

set system user <username> **display-name** <display_name>

Command arguments

<username>	Name of the user
<display_name>	Display name to easily identify the user

Example

```
set system user smith display-name primeuser
```

Enabling or disabling CLI access

You can control a user's access to the CLI. By default, users will have access to the CLI.

set system user <username> **no-cli-access** [**true** | **false**]

Command arguments

<username>	Name of the user
<true | false>	When the no-cli-access is set to true, the user's access to the CLI is disabled. When the no-cli-access is set to false, the user will be able access the CLI.

Example

```
set system user smith no-cli-access false
```

Collecting Debug Information

You can collect the debug information using the following command:

```
set system user <username> role debug_info
```

Configuring sudo Without Password

You can configure local system users to log in via passwords or using SSH keys. From a security perspective, it is desirable to allow authentication with SSH keys only. RBFS provides a configuration knob to disable the requirement for a 'sudo' password so that local users can authenticate with SSH keys only. This knob is configurable only if the user or one of its roles is supervisor.

You can enter the following command to enable or disable the 'sudo' password. By default, this is set to false which ensures that the supervisor must provide a password when using sudo.

set system user <user> **no-sudo-password** < **true** | **false** >

Command arguments

<username>	Name of the user
<true | false>	When the no-sudo-password is set to true, it indicates that a 'sudo' password is not required. When it is set to false, it indicates that the supervisor must provide a password when using sudo.

Example Configuration:

```
{
    "rtbrick-config:user": [
      {
        "username": "smith",
        "role": "supervisor",
        "shell": "/bin/bash",
        "ssh-pub-key": "ssh-rsa AAAAB3Nza<...>",
        "no-sudo-password": "true"
      }
    ]
 }
```



If 'no-sudo-password' is set, you can log in with your SSH key.

Configuring Fail2Ban

The failed SSH login attempts from one user over an SSH jump host affect other users from the same jump host. You can configure Fail2Ban, which enables you to

whitelist some IP addresses by creating separate jails for each user connecting through the jump host. In this way, failed login attempts by one user will not affect another user.

The following Fail2Ban command allows you to configure a list of IP addresses to include those IP addresses in the whitelist. You can specify multiple IP addresses that you want to exclude from the ban. Fail2Ban is applicable to both the RtBrick Host and the Linux container.

Syntax:

set system platform-management fail2ban ignore-ip <ignore-ip>

Command arguments

ignore-ip <ignore-ip>	Specify the IP addresses in CIDR notation which are to be whitelisted.

Example commands for configuration:

```
supervisor@rtbrick>LEAF01: cfg> show config set
set system
set system platform-management fail2ban ignore-ip 10.1.1.1/32
set system platform-management fail2ban ignore-ip 10.1.1.2/32
set system platform-management fail2ban ignore-ip 10.2.2.0/24
```

Example Configuration:

```
supervisor@rtbrick>LEAF01: cfg> show config
{
  "ietf-restconf:data": {
    "rtbrick-config:system": {
      "platform-management": {
        "fail2ban": {
          "ignore-ip": [
            "10.1.1.1/32",
            "10.1.1.2/32",
            "10.2.2.0/24"
            ]
        }
      }
    }
  }
}
```

Enabling or Disabling Password-based Authentication

The "set system authentication ssh" CLI allows modifying the SSH configurations on the device. The password-authentication option disables the password-based authentication for user login. By default, password-based authentication is enabled. Additionally, two more SSH authentication parameters can be configured: client-alive-count-max and client-alive-interval.



After disabling password-based authentication, the device will not be accessible through password-based login; hence, you must configure a public key for the user before disabling this. If you have disabled password authentication by mistake and forgot to configure the public key, you can only recover the device using RESTCONF by configuring the password authentication to “true.”

Syntax:

set system authentication ssh <attribute> <value>

Attribute	Description
client-alive-count-max	Defines the maximum number of unanswered keepalive messages before terminating the connection.
client-alive-interval	Sets the interval (in seconds) for sending keepalive messages to the client to prevent idle disconnections.
password-authentication	Enables or disables password-based authentication, set to 'false' to enforce key-based authentication for enhanced security.

The example below shows disabling password-based authentication and logging in using SSH key.

```
supervisor@rtbrick: cfg> set system authentication ssh password-authentication false
supervisor@rtbrick: cfg> commit
supervisor@rtbrick: cfg> set system user supervisor
supervisor@rtbrick: cfg> set system user supervisor shell /bin/bash
supervisor@rtbrick: cfg> set system user supervisor ssh-pub-key "ssh-ed25519
ABCDEFC1lZDI1NTE5AAcRsYHrrTesQr04UuSrtefN/ndezZM7+8mBC"
supervisor@rtbrick: cfg> commit
supervisor@rtbrick: cfg>
```

Configuration Example:

```
{
    "ietf-restconf:data": {
        "rtbrick-config:system": {
            "authentication": {
                "ssh": {
                    "password-authentication": "false"
                }
            },
            "user": [
                {
                    "username": "supervisor",
                    "shell": "/bin/bash",
                    "ssh-pub-key": [
                        "ssh-ed25519 ABCDEFC1lZDI1NTE5AAcRsYHrrTesQr04UuSrtefN/ndezZM7+8mBC"
                    ]
                }
            ]
        }
    }
}
```

The example below shows how to log into the device after disabling password-based authentication.

```
supervisor@rtb:~$ ssh supervisor@bl1-pod1
Last login: Wed Feb 26 07:28:06 2025 from 192.168.1.135
supervisor@rtb:~$ ssh supervisor@bl1-pod1
Last login: Wed Feb 26 07:28:06 2025 from 192.168.1.135

+----------------------------------------------------------------------+
|                                                                      |
    System rtbrick running on ufi15.q2c.u15.r5.nbg.rtbrick.net:
        Date:       Thu Nov 20 06:21:58 AM UTC 2025
        Uptime:     up 1 hour, 2 minutes

    Image metadata:
        UUID:       0aef95f4-3d2a-4bdc-90aa-784231ad9e5d
        Version:    25.4.1-candidate.3
        Role:       multiservice-edge
        Platform:   q2c
        Model:      s9600-72xc
        Format:     lxd
        Build date: 2025-11-19 08:52:54 UTC
        Based on:   Debian GNU/Linux 12 (bookworm)

    RBFS License:
        No license found
|                                                                      |
+----------------------------------------------------------------------+
```

The example below show how to re-enable the password-based authentication and log in to the device.

```
supervisor@rtbrick: cfg> set system authentication ssh password-authentication true
supervisor@rtbrick: cfg> commit
supervisor@rtbrick: cfg> delete system user supervisor
supervisor@rtbrick: cfg> commit
supervisor@rtbrick: cfg>
```

Configuration Example:

```
{
    "ietf-restconf:data": {
        "rtbrick-config:system": {
            "authentication": {
                "ssh": {
                    "password-authentication": "true"
                }
            }
        }
    }
}
```

The example below shows how to log into the device after enabling password-based authentication.

```
ssh supervisor@ufi15.q2c.u15.r5.nbg.rtbrick.net
supervisor@ufi15.q2c.u15.r5.nbg.rtbrick.net's password:
+---------------------------------------------------------------------+
|                                                                     |
    RBFS container rtbrick running on ufi15.q2c.u15.r5.nbg.rtbrick.net:
        Date:       Thu Nov 20 06:21:58 AM UTC 2025
        Uptime:     up 1 hour, 2 minutes

    Image metadata:
        UUID:       0aef95f4-3d2a-4bdc-90aa-784231ad9e5d
        Version:    25.4.1-candidate.3
        Role:       multiservice-edge
        Platform:   q2c
        Model:      s9600-72xc
        Format:     lxd
        Build date: 2025-11-19 08:52:54 UTC
        Based on:   Debian GNU/Linux 12 (bookworm)

    RBFS License:
        No license found
|                                                                     |
+---------------------------------------------------------------------+
```

9.3.3. LUM Operational Commands

The show commands to display information about local and TACAS+ users and their sessions. You can use the command and options to view the summary of all users, information for a specific user and to view user sessions details.

LUM Show Commands

User Details

Syntax:

show user <option>

Option	Description
session <session-id>	Displays information about user session ID specified.

Example: The output shows the currently logged-in users along with their roles, authentication methods, source IP addresses, login time and session details.

```
supervisor@rtbrick.net: op> show user
Username     Role          Shell     SSH-Key   Authenticator  Source IP
Login Time            Session ID
supervisor   supervisor    bash      No        Local          10.254.253.23
2025-10-16 05:44:41   142778
user         supervisor    bash      No        TACACS+        10.254.253.23
2025-10-16 05:45:20   142783
```

Example: The output shows the detailed information about a specific user session, including the login method, role, shell, service, and connection details such as host, session duration, and idle time.

```
supervisor@rtbrick.net: op> show user session 140229
Session Information:
Name            : user
Session ID      : 140229
TTY             : pts/6
Display Name    : user
Host            : 10.210.65.87
PID             : 860921
Public Key      : False
Login Method    : TACACS+
Role            : supervisor
Shell           : bash
Service         : sshd
State           : active
Login Time      : 2025-10-14 05:22:00
Session Duration: 4h 43m 49s
Idle Timestamp  : 2025-10-14 08:27:06
Idle Duration   : 1h 38m 43s
```

9.4. sFlow

9.4.1. RBFS sFlow Technology

sFlow Overview

sFlow is a packet-sampling protocol for monitoring network traffic. sFlow enables continuous, real-time monitoring of network traffic across all interfaces simultaneously. It works by collecting samples of data packets and transmitting these samples in UDP datagrams to a central station called collector.

The sampling process is directly handled by the networking processing ASIC, which ensures accuracy in packet sampling and also significantly reduces the utilization of control-plane resources such as CPU, memory.

sFlow provides insights into network traffic that enables the network operator to promptly identify performance issues, security threats, or unusual traffic patterns. It allows real-time network monitoring across thousands of router ports simultaneously in a large scale environment.

Packet-Based Sampling:

Packet-based sampling is a technique for capturing a subset of network traffic by selecting one packet from a predefined number of packets. It generates a representative sample of the overall traffic without capturing every packet, which would be resource-intensive.



- RBFS sFlow mechanism captures only the packet headers passing through the incoming and outgoing physical interfaces.
- The sFlow header for Q2A-based platforms (Edgecore CSR440 and UfiSpace S9510-28DC) includes the 'In-ifindex' and 'Out-ifindex' fields.

Benefits of sFlow Technology

sFlow offers the following benefits:

Detect Network Issues and Manage Real-time Congestion: sFlow provides visibility into traffic patterns and enables the detection of anomalies such as

misconfigurations, packet loss, and latency and it can track unauthorized activities. It can monitor traffic flow and bandwidth usage in real-time and provides data to manage network congestion.

For example, if an RBFS device suddenly experiences high latency or packet loss, sFlow provides information to pinpoint the source of the issue, such as a faulty interface or a congested port.

Types of Applications and Usage Patterns: By analyzing packet headers, sFlow can identify different types of network traffic such as web browsing, peer-to-peer (P2P), and DNS queries. This helps you to understand the types of applications and the amount of bandwidth that they consume. It allows to track changes in resource usage.

For example, if a network experiences an increase in P2P traffic, sFlow can provide the cause and the users or applications that are involved. With this data, network administrators can take appropriate actions.

Billing and Charge-Back: sFlow can provide resource usage data on per-application or per-user basis, which is useful for enterprise customers that require billing or internal charge-back. Enterprises can utilize this data to accurately bill customers or to allocate costs to internal departments based on the actual network consumption.

Route Profiling and Peering Optimization: sFlow captures detailed routing information and traffic distribution that helps to analyze traffic patterns across different routes and optimize peering agreements. It helps to refine routing policies and peering relationships.

For example, service providers can use sFlow data to determine which peering partners receive most of the traffic. This information allows you to modify their peering policies to improve performance.

Trends and Capacity Planning: sFlow can provide data on traffic trends and bandwidth usage that helps you to increase capacity.

For example, you can see a particular link is nearing its bandwidth capacity by analyzing sFlow data. With this data, you can plan an upgrade.

Understanding RBFS sFlow Implementation

sFlow works by capturing sample network packets and collecting data periodically to give a representative view of the overall traffic. It does not capture every packet, instead, it samples a subset of packets. For example, it captures one packet in every N packets (where N is configurable) on a physical interface.

sFlow Components

An RBFS sFlow system comprises an sFlow agent embedded in a device and a remote sFlow collector.

sFlow Agent

The sFlow agent gathers data by sampling packets from the ports which are configured for sFlow. It then encapsulates this data into UDP datagram and sends the samples to the collector. The sFlow collector analyzes these samples to give you data about traffic patterns, issues, and performance of the network.

sFlow Agent is a key component and performs the following tasks:

1. Sampling to collect packet samples based on the defined number of packets
2. Process the collected packets
3. Export the UDP datagram to the sFlow collector

For sending the sampled packets, you can configure a destination port. The default destination port is 6343.

sFlow Collector

The collector receives the sampled data from the sFlow agents. It aggregates, processes, and stores the data for analysis. The collector can analyze and interpret metrics such as packet types, bandwidth usage, IP addresses, protocol information, and so on.

Flow Sampling and Number of Samples

With the packet sampling, an sFlow agent samples packets on a designated interface based on a sampling rate that is set.

Each sFlow packet carries sampled data, and the number of samples determines

the amount of data included in a single packet. In RBFS, the number of samples in every sFlow packet by default is 1. It means each sFlow packet contains one sampled record.

Guidelines for sFlow Settings

- To successfully transport sFlow data to the collector, make sure the routing table includes a route that enables communication with the collector's configured IPv4 address. Specifically, there should be a route entry for the collector's IPv4 address within the instance where the sFlow collector is configured. This ensures that the device knows the correct path to reach the collector's IP address within the specified routing instance, allowing sFlow data transit to the collector.
- The agent ID must be identical across all collectors configurations within a device. This ensures the source of sampled data is recognized as the same across multiple collectors.
- It is required to enable sFlow on each interface individually by attaching a traffic-sampling profile. This profile defines the collector IP address, sampling direction and so on.
- You can configure a maximum number of four different collectors to receive sampled traffic.



When the interface is attached to a traffic-sampling profile, attaching a mirror to the same interface may prevent sampling from working.

Supported Platforms

Not all features are necessarily supported on each hardware platform. Refer to the *Platform Guide* for the features and the sub-features that are or are not supported by each platform.

9.4.2. sFlow Configuration

Configuration Hierarchy

The following diagram illustrates the sFlow configuration hierarchy. In this configuration hierarchy, traffic sampling collectors and traffic sampling profiles are

set up under forwarding-options to enable packet sampling using the sFlow protocol. After defining the collectors and sampling profiles, the sampling profile can be attached to the physical interfaces that allows the device to sample traffic from that interfaces.

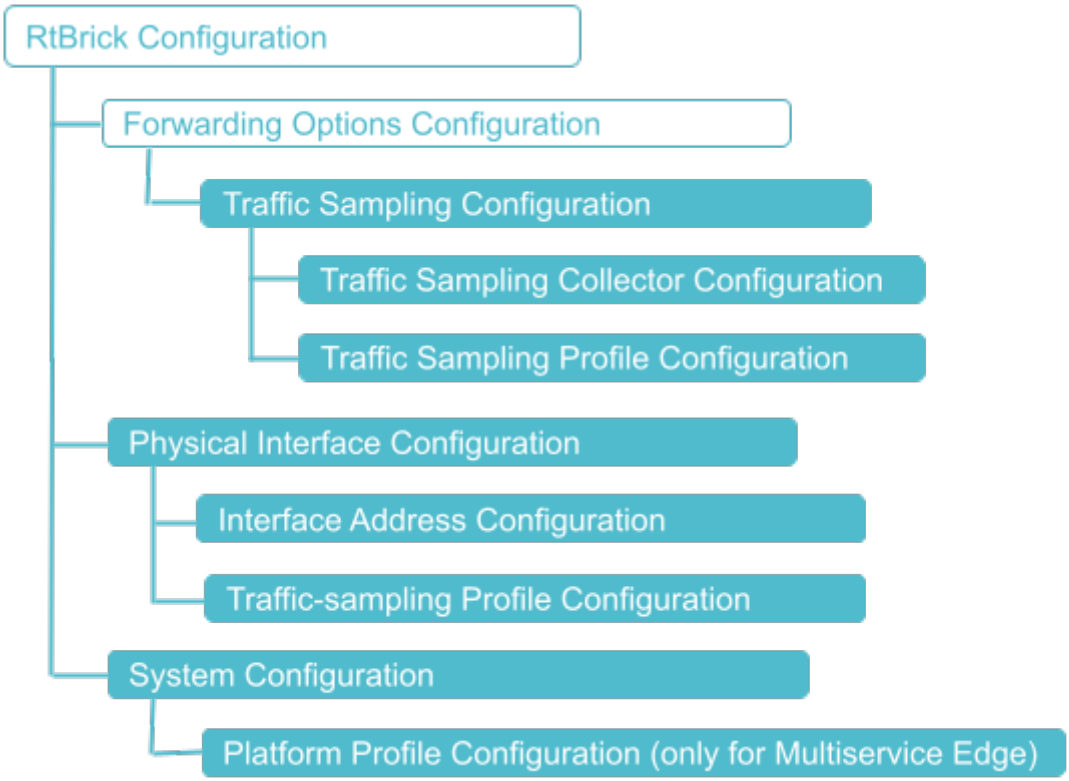


Figure 156. sFlow Configuration Hierarchy

Configuration Syntax and Commands

The following sections describe the sFlow configuration syntax and commands.

Prerequisites:

Before configuring sFlow, ensure that the appropriate platform profile is configured on the device. The platform profile determines the operating mode of the system and enables the required hardware resources for sFlow functionality.

You must configure "sFlow" parameter for the Platform Profile for on multiservice edge devices only. The Spine and Access-Leaf devices do not require this platform profile settings. You must reboot the device for the changes to take effect after completing the Platform Profile configuration.

For information about platform profile configuration, see Platform Profile

Configuration.

Syntax

set system platform profile <profile-name>

Attribute	Description
profile_name	Name of platform profile
feature	Feature name.

Example commands:

This configuration defines a platform profile named 'nat_4q' that enables the sFlow feature.

```
set system platform profile nat_4q
set system platform profile nat_4q feature sFlow
```

```
supervisor@rtbrick.net: op> show config system platform
{
  "rtbrick-config:platform": {
    "profile": [
      {
        "profile_name": "nat_4q",
        "feature": [
          "sFlow"
          ]
      }
    ]
  }
}
```

sFlow Collector Configuration

You can configure a maximum number of four collectors to receive sampled traffic.



The agent ID must be identical across all collectors. This ensures the source of sampled data is recognized as the same across multiple collectors.

You can create, modify, or delete collectors dynamically, while the device continues to operate. This gives you the flexibility to modify the configurations of

the sFlow collectors without causing any downtime.

Syntax

set forwarding-options traffic-sampling collector <collector-id> <attribute> <value>

Example commands:

```
set forwarding-options traffic-sampling collector 1
set forwarding-options traffic-sampling collector 1 instance default
set forwarding-options traffic-sampling collector 1 export-protocol sflow
set forwarding-options traffic-sampling collector 1 address ipv4 10.1.1.1
set forwarding-options traffic-sampling collector 1 sampling-rate 100
set forwarding-options traffic-sampling collector 1 destination-udp-port 6343
set forwarding-options traffic-sampling collector 1 agent-id 1.2.3.4
```

Attribute	Description
collector-id	Identifier for each collector.
agent-id	Unique identifier for the device sending sFlow data. This ID must be the same across all collectors.
collector-ip	The IP address of the collector to which the sFlow UDP data gram is sent.
instance	The Instance of collector IP reachability.
destination-udp-port	The UDP port used for sending sFlow data to the collector (Default: 6343).
sampling-rate	Specifies the rate at which the packets are sampled. Range: 100 - 50,000. Example: When configured as 100, 1 packet out of 100 packets gets sampled.
export-protocol	The protocol for sending the captured sample packets to the collector (Protocol used is sFlow).

Example: Collector configuration

The following configuration sets up sFlow collectors. Each collector is assigned with a unique ID and is configured with an IP address to receive the sampled traffic, along with parameters like sampling rate, number of samples, and the destination UDP port for sFlow data. The same agent ID (1.2.3.4) is used for all collectors. The

sampled traffic is sent to the collector's IP address, 10.1.1.1, over UDP port 6343. All collectors operate within the 'default' instance.

Collector 1 is configured with a sampling rate of '1' that indicates every packet traversing the configured interface is sampled without skipping any packet. The number of samples specified is 3, which indicates that the individual packets are aggregated into groups of three samples before being exported to the collector. The sFlow agent, which is the device or system sending the traffic samples, is defined by the agent identifier '1.2.3.4'.

In this configuration, collectors 2, 3, and 4 sample every 10th packet but differ in the number of samples and destination ports. Agent ID 1.2.3.4 is configured for all collectors 2, 3, and 4.

```
{
    "rtbrick-config:forwarding-options": {
        "traffic-sampling": {
            "collector": [
                {
                    "collector-id": 1,
                    "instance": "default",
                    "export-protocol": "sflow",
                    "address": {
                        "ipv4": "10.1.1.1"
                    },
                    "sampling-rate": 100,
                    "destination-udp-port": 6343,
                    "agent-id": "1.2.3.4"
                },
                {
                    "collector-id": 2,
                    "instance": "default",
                    "export-protocol": "sflow",
                    "address": {
                        "ipv4": "20.1.1.1"
                    },
                    "sampling-rate": 100,
                    "destination-udp-port": 6343,
                    "agent-id": "1.2.3.4"
                },
                {
                    "collector-id": 3,
                    "instance": "default",
                    "export-protocol": "sflow",
                    "address": {
                        "ipv4": "30.1.1.1"
                    },
                    "sampling-rate": 100,
                    "destination-udp-port": 6343,
                    "agent-id": "1.2.3.4"
                },
                {
                    "collector-id": 4,
                    "instance": "default",
```

```
                    "export-protocol": "sflow",
                    "address": {
                        "ipv4": "40.1.1.1"
                    },
                    "sampling-rate": 100,
                    "destination-udp-port": 6343,
                    "agent-id": "1.2.3.4"
                }
            ]
        }
    }
}
```

Traffic-Sampling Profile Configuration

You can create a traffic sampling profile that can be attached to the physical interface .

Syntax

set forwarding-options traffic-sampling profile <profile-name> **collector-id** <collector-id> **description** <description> **direction** [ingress\|egress\|both]

Example set of commands:

```
set forwarding-options traffic-sampling profile test
set forwarding-options traffic-sampling profile test collector 1
set forwarding-options traffic-sampling profile test direction ingress
set forwarding-options traffic-sampling profile test export-protocol sflow
```

Attribute	Description
profile-name	Name of the sampling profile.
collector-id	The identifier of the collector to which the packet samples are sent.
direction	Defines whether traffic sampling is performed on ingress, egress, or both of the directions.
description	Description for the profile.

Example: Traffic sampling profile configuration

This configuration defines two traffic sampling profiles that control how network

traffic is sampled and exported to specific collectors using the sFlow protocol. Each profile focuses on capturing only incoming traffic on the monitored interfaces and exports this data to a designated collector for analysis.

The first profile, named "test", is configured to send the collected traffic data to Collector 1. This profile is designed to focus on incoming traffic.

The second profile, named "test1", has a similar configuration. It also monitors only incoming traffic, using the sFlow protocol to export the data. The traffic collected under this profile is directed to Collector 2.

```
{
    "rtbrick-config:forwarding-options": {
        "traffic-sampling": {
            "profile": [
                {
                    "profile-name": "test",
                    "collector": 1,
                    "direction": "ingress",
                },
                {
                    "profile-name": "test1",
                    "collector": 2,
                    "direction": "ingress",
                }
            ]
        }
    }
}
```

Attach Traffic-Sampling Profile with the Physical Interface

You can attach a traffic sampling profile to a physical interface using the following command.

Syntax

set interface <interface-name> **traffic-sampling-profile** <profile-name>

Example Command:

```
set interface ifp-0/1/10 traffic-sampling-profile test1
```

Attribute	Description
interface-name	Name of the physical interface.
<profile-name>	Name of the profile.

Example: Traffic sampling profile is attached on multiple physical interfaces.

This configuration sets up a few physical interfaces with different speeds. Some of these interfaces have traffic sampling profiles configured. Two interfaces (ifp-0/1/10 and ifp-0/1/8) are configured with traffic sampling profiles ('test1' and 'test', respectively).

```
[
    {
        "name": "ifp-0/1/10",
        "speed": "10G",
        "traffic-sampling-profile": "test1",
        "unit": [
            {
                "unit-id": 1,
                "address": {
                    "ipv4": [
                        {
                            "prefix4": "121.0.0.1/24"
                        }
                    ],
                    "ipv6": [
                        {
                            "prefix6": "fc66:1337:7331::1/64"
                        }
                    ]
                }
            },
            {
                "unit-id": 25,
                "vlan": 25,
                "address": {
                    "ipv4": [
                        {
                            "prefix4": "10.1.1.2/24"
                        }
                    ]
                }
            },
            {
                "unit-id": 26,
                "vlan": 26,
                "address": {
                    "ipv4": [
                        {
                            "prefix4": "20.1.1.2/24"
                        }
                    ]
                }
            }
```

```
        ]
    },
    {
        "name": "ifp-0/1/20",
        "speed": "10G"
    },
    {
        "name": "ifp-0/1/26",
        "speed": "1G"
    },
    {
        "name": "ifp-0/1/5",
        "speed": "1G"
    },
    {
        "name": "ifp-0/1/6",
        "speed": "1G"
    },
    {
        "name": "ifp-0/1/61",
        "speed": "10G"
    },
    {
        "name": "ifp-0/1/63",
        "speed": "10G"
    },
    {
        "name": "ifp-0/1/8",
        "speed": "10G",
        "traffic-sampling-profile": "test"
    },
    {
        "name": "ifp-0/1/9",
        "speed": "10G"
    },
    {
        "name": "lo-0/0/4",
        "unit": [
            {
                "unit-id": 1,
                "address": {
                    "ipv4": [
                        {
                            "prefix4": "1.2.3.4/24"
                        }
                    ]
                }
            }
        ]
    }
]
```


9.4.3. sFlow Operational Commands

sFlow Collector Information

The show traffic-sampling sflow collector command output provide details about

the sFlow collectors configured on the device. It shows the information related to each collector, including its sampling rates, associated agent, destination IP address, and other configuration specifics.

Syntax:

show traffic-sampling sflow profile <profile-name> **collector** <collector-id>

Option	Description
<profile-name>	Name of the profile.
collector-id	Identifier for the collector.

Example 1: Summary Output for sFlow collectors

```
supervisor@rtbrick: op> show traffic-sampling sflow collector
Collector ID: 1
    Agent-ID: 1.2.3.4
    Address: 10.1.1.1
    Instance: default
    Number of samples: 5
    Sampling-rate: 10
    UDP-Destination-Port: 6343
Collector ID: 2
    Agent-ID: 1.2.3.4
    Address: 20.1.1.1
    Instance: default
    Sampling-rate: 10
    UDP-Destination-Port: 6343
    Interval: 4 secs
Collector ID: 3
    Agent-ID: 1.2.3.4
    Address: 30.1.1.1
    Instance: default
    Number of samples: 3
    Sampling-rate: 10
    UDP-Destination-Port: 6344
Collector ID: 4
    Agent-ID: 1.2.3.4
    Address: 40.1.1.1
    Instance: default
    Number of samples: 2
    Sampling-rate: 10
    UDP-Destination-Port: 6344
```

Example 2: Summary Output for a specified sFlow collector

```
supervisor@rtbrick: op> show traffic-sampling sflow collector 1
Collector ID: 1
    Agent-ID: 1.2.3.4
    Address: 10.1.1.1
    Instance: default
    Number of samples: 5
    Sampling-rate: 10
    UDP-Destination-Port: 6343
```

Sampling Profiles

Displays the packet sampling profile related information.

Syntax:

show traffic-sampling profile <options>

Option	Description
<profile-name>	Name of the profile.

Example 1: Summary Output for traffic sampling profiles

```
supervisor@rtbrick: op> show traffic-sampling sflow profile
Profile name: test
    Collector Id: 1
    Direction: ingress
Profile name: test1
    Collector Id: 2
    Direction: ingress
```

Example 2: Summary Output for traffic sampling for a specified profile

```
supervisor@rtbrick: op> show traffic-sampling sflow profile test
Profile name: test
    Collector Id: 1
    Direction: ingress
```

10. Telemetry

10.1. TSDB

10.1.1. Observability

RBFS runs Prometheus, an open-source monitoring tool with a built-in time-series database. It gathers metrics (data) from RBFS and its microservices (brick daemons). Prometheus uses a polling model and pulls metrics data.

RBFS includes a pre-packaged Prometheus software and it does not require a separate Prometheus installation. However, to begin collecting and storing data, you must enable Prometheus observability on an RBFS device. It remains inactive until a time-series has been configured for the first time.

Prometheus observability is an optional service in RBFS.

Understanding Prometheus Observability in RBFS

Prometheus operates as a microservice in the RBFS container and it queries at regular intervals to pull metrics data directly from various RBFS brick daemons or processes. It collects metrics and stores them with the timestamp, which shows when the data was recorded. RBFS supports direct export of metrics to Prometheus.

By monitoring and analyzing these metrics, you can assess the health of your applications, detect any anomalies, and take necessary corrective actions. You can define custom metrics.

Prometheus pulls metrics periodically from all targeted processes at a scrape interval. A scrape interval indicates how frequently these metrics are collected.

At a high level, three key operations take place:

- Prometheus scrapes metrics from various applications and services at regular intervals.
- The collected data is stored in a time-series database for querying and analysis.
- Alert rules analyze the data and triggers alerts to notify about the critical events or anomalies.

Example of Scenarios When or How Time-Series Metrics Data Help

The following are a few example scenarios of how and when the observability data help network administrators:

- Detecting Memory Leaks: A gradual increase in memory usage without a corresponding change in the PPPoE session count indicates a memory leak.
- Predicting Hardware Failures: A persistent five-minute chassis temperature readings signals an imminent hardware fault, prompting a replacement.
- Identifying Fabric Congestion: Consistent 80 percent utilization across all fabric interfaces suggests the need to add new fabric links.
- Detecting Weakening Optical Links: When a network device receives a high volume of incoming traffic and simultaneously shows a drop in optical receive power, suggests that the optical signal is weakening.

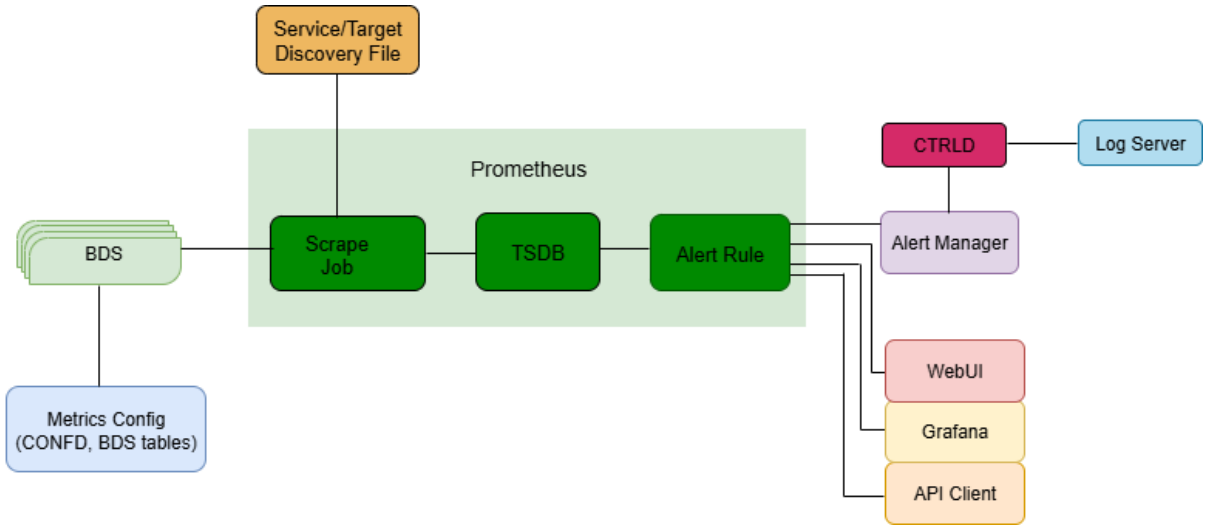


Figure 157. Prometheus Monitoring in RBFS

The communication uses the Prometheus exposition format, which operates through an HTTP pull from the metrics endpoint of the scrape target.

RBFS brick daemons communicate to the configuration table called global.time-series.metric.config, which lists the metrics a daemon is supposed to export. Only the BDS, which holds the data table for each daemon, responds with metrics. The data scraped by Prometheus is stored in its own local time-series database on the device.

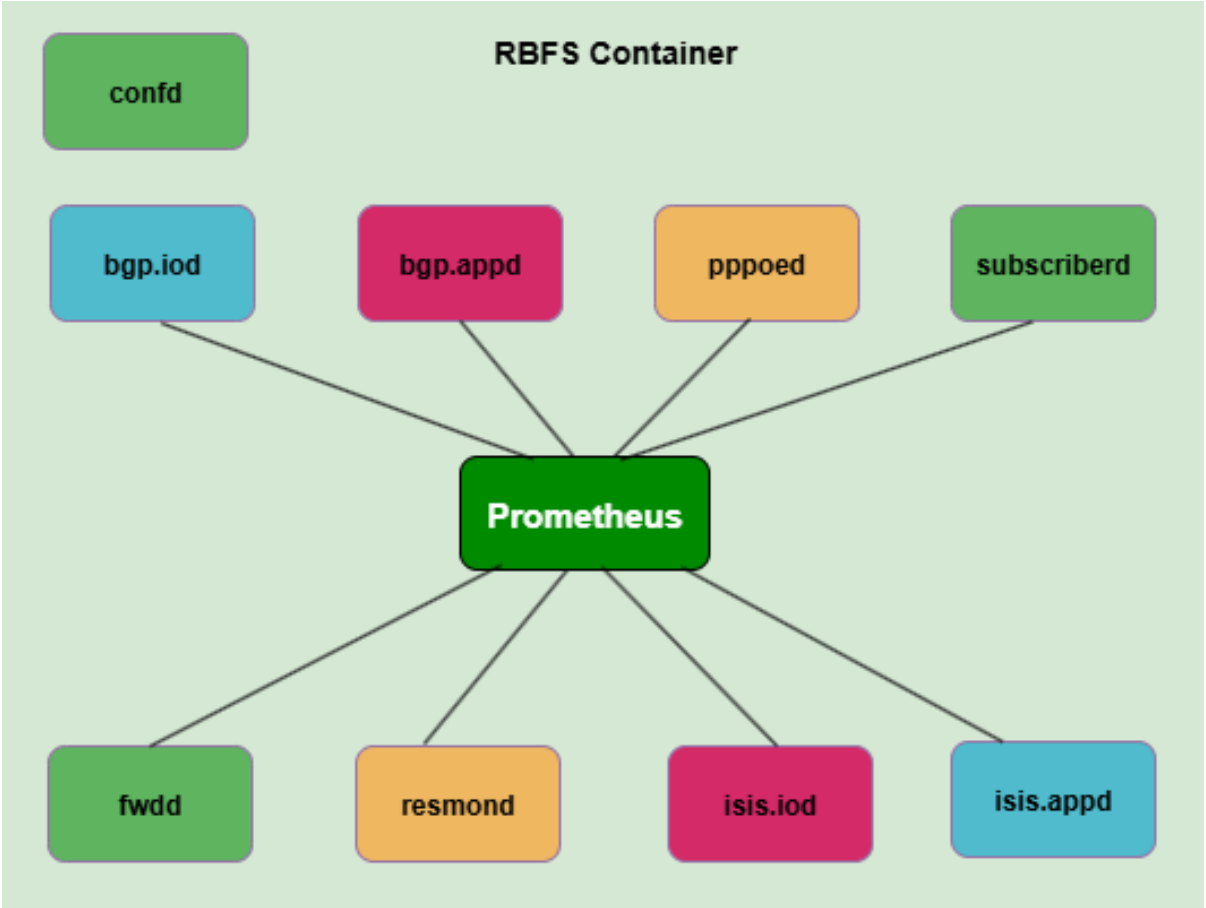


Figure 158. Prometheus in RBFS with the different scrape target

Visualization

RBFS supports Grafana, a visualization platform, to present metrics data visually. For more information, see Grafana.

Federated Deployment of Prometheus

In a federated Prometheus deployment model, multiple Prometheus instances can be deployed hierarchically in large-scale environment. A global Prometheus instance aggregates data from other Prometheus nodes enabling hierarchical data collection. This hierarchical structure helps manage large volumes of time-series data. It is useful for environments where a single Prometheus instance is inadequate.

Prometheus Federation allows you to consolidate metrics from multiple Prometheus instances into a single, centralized instance.

The following prometheus.yml file demonstrates the global Prometheus instance configured to scrape metrics from local Prometheus instances using the '/federate' endpoint:

```
global:
  scrape_interval: 60s

scrape_configs:
  - job_name: "federate"
    honor_labels: true
    metrics_path: '/federate'
    params:
      'match[]':
        - '{job=~"^bds_.+"}'
    scrape_interval: 15s
    file_sd_configs:
      - files:
          - ./bds.target.yml
        refresh_interval: 5m
```

The 'match[]' parameter indicates the global Prometheus instance to retrieve only time-series metrics associated with the BDS job. This ensures efficient data selection and eliminates the need to modify the configuration when new aggregation rules are introduced.

The Prometheus targets, which are the local Prometheus instances from which to pull data, are defined in the 'bds.target.yml' file:

```
- targets: ['198.51.100.125:19091']
  labels:
    __metrics_path__:
"/api/v1/rbfs/elements/rtbrick/services/prometheus/proxy/federate"
    box: 125_rtbrick
```

This configuration specifies the endpoint to scrape and assigns custom labels to the data, such as identifying the RBFS device.

For more information about Prometheus Federation, see Prometheus Federation.

Control Daemon

Control Daemon (CtrlD) is a key component that facilitates service discovery, state monitoring, and proxying for other services within a monitoring architecture. It interacts with Prometheus for metrics collection and Alertmanager for alert management.

CtrlD operates as a proxy and acts as a middle layer to handle requests without querying Prometheus directly. Both Prometheus and Alertmanager are registered with CtrlD, allowing it to be aware of their existence and track their operational state (whether they are up or down). Alertmanager manages alerts triggered by

Prometheus based on predefined conditions. When an alert is triggered in Alertmanager, CtrlD forwards these alerts to external destinations, such as Grafana.

CtrlD can also be used to make Prometheus queries via HTTP. For example:

```
curl
'http://198.51.100.125:19091/api/v1/rbfs/elements/rtbrick/services/prometheus/prox
y/api/v1/query?query=up' | jq .
```

This command queries Prometheus to check the status of the services to see if they are up.

For federation, the following URL allows for sharing data between multiple Prometheus instances:

```
http://198.51.100.125:19091/api/v1/rbfs/elements/rtbrick/services/prometheus/proxy
/federate
```

Down-sampling:

RBFS supports down-sampling for Prometheus federated deployment. It helps to reduce the amount of stored data by averaging, aggregating, or sampling over a specified period of time. The mechanism involves grouping the data over time periods and calculating things based on averages, sums, or maximums.

Metrics and Metric Profiles

Metrics

Metrics are data points that are recorded with a timestamp to create a metric time-series. The metric as such is the current value. Storing the metric values with a timestamp forms a metric time-series which can then be scanned for anomalies or used for trend analysis. Metrics are often accompanied by labels, which provide additional context about the data. For example, a CPU usage metric can include labels that indicate the instance or application that it belongs to.

Index Metrics and Object Metrics:

Index Metric and Object Metrics are two different ways of storing and querying time-series data. They differ in how they are used to store and retrieve time-series

data. Index-metrics refer to metrics stored within the index of Prometheus.

Object-metrics are the actual data points, stored within the Prometheus. They represent the measured values over time.

Metric Filters

Filters allow you to include or exclude specific BDS objects based on the objects attributes. The filtering is only applicable on 'bds-type object-metric', it is not supported on 'index-metric'.

For more information, see Metrics.

Attributes

Attributes represent the numeric fields (columns) in BDS tables that are monitored and exported as time-series metrics. These are the actual data points such as packet counters, byte counters and so on. Attributes are key elements because they determine the specific information to be collected. The attributes specify which state will be exported.



This attribute must be either a numeric type or a type that can be converted to numeric.

Labels

Labels (Attribute Labels) provide additional context and metadata about metrics. They are key-value pairs attached to metrics. Labels help differentiate between different instances of the same attribute. For example, when Prometheus monitors multiple applications simultaneously, each application may have a system_memory_used_bytes metric. Labels enable Prometheus to store multiple metrics from various sources under a single metric name.

Moreover, attribute labels are useful for filtering, grouping, and analyzing metrics across different entities. They are necessary for uniquely identifying metric streams, especially when the same attribute appears in multiple rows of a table.

For more information, see Metrics Labels.

Filters

Filters (Attribute Filters) are used to narrow down the objects of a table should be considered for metric generation. In some tables, there may be hundreds of entries, but you may only track metrics for a few specific rows. Filters let you define conditions (match rules) that rows must meet to be included in metric generation.

Metric Profiles

In RBFS, you can create metric profiles that allow you to group multiple metrics which share the same characteristics, such as metrics from the same application or instances. Instead of configuring each metric individually, you can define the scrape interval and the append-timestamp flag commonly for all associated metrics in a metric profile.

If you do not explicitly assign a metric to a specific metric profile, it will be by default assigned to the default metric profile. This default profile is set to scrape metrics every 5 seconds. If you do not create or use any custom metric profile, all metrics will automatically fall under this default profile. Also, if you do not define any custom metric profile, Prometheus scrapes all daemons that expose metrics in every 5 seconds.

Alert and Alert Profiles

Alert

You can configure Prometheus to generate alerts based on defined rules, which are then managed by the Alert Manager.

Alerts are triggered based on rules that evaluate time-series data stored in the Prometheus. When the specified conditions are met, the alert manager notifies CtrlD which forwards the notification to the configured GELF or syslog servers.

For more information, see Alerting and Alertmanager.

Alert Profile

An alert profile allows you to group multiple alerts into a single profile by applying the same characteristics to them. The alert profile also controls the repeat interval, which specifies how often a notification will be repeated if the underlying alert condition remains unresolved.

Tracking Invalid Time-series Configurations

RBFS provides the ability to track invalid time-series configurations applied to RBFS. This functionality helps to debug Prometheus time-series that are not in the expected state (for example, missing labels) due to configuration settings that cause runtime issues. This functionality is enabled by default. You can view the list of misconfigurations using the show command: show time-series metric <metric-name> rtbrick_invalid_metric_config.

Monitoring Daemon Status

The built-in Prometheus 'up' metrics must not be used to monitor the brick daemons. Prometheus scrapes only metrics from daemons that actually expose metric data. RBFS allows you to monitor the state of the daemons whether they are operational or not. You can enable the functionality. For configuration information, see section Monitoring Daemon Status.

Prometheus Self-Monitoring

With the self-monitoring functionality, Prometheus can monitor its own performance and health. This functionality gathers metrics related to Prometheus' own operations that include query performance and resource usage.

Append Timestamp

RBFS allows you to enable Append Timestamp on both metric or metric profile level. When the append timestamp flag is set, the first metric generated after an object is updated will include the actual timestamp of the update. This accurately reflects when the change took place. For all subsequent metrics for the same object (since it has not been updated again) the current scrape time will be used.

Storage

On average, Prometheus uses only about 1 to 2 bytes per sample. Therefore, to plan the capacity of a Prometheus server, you can use the following rough formula:

```
needed_disk_space = retention_time_seconds * ingested_samples_per_second *
bytes_per_sample
```

The disk space for the single binaries:

```
-rwxr-xr-x 1 root root 27M Sep 2 22:51 alertmanager +
-rwxr-xr-x 1 root root 81M Sep 2 22:51 prometheus +
-rwxr-xr-x 1 root root 49M Sep 3 19:55 promtool
```

Use the 'promtool' for testing configurations before setting them in Prometheus. For information, see promtool.

For more information about storage, see Storage.

10.1.2. Time-series Configurations in RBFS

Configuration Overview

RBFS does not require a separate Prometheus software installation as it includes a pre-packaged Prometheus software. The time-series configuration defines how time-series data is collected, stored, and transported to external systems. The configuration allows RBFS to stream time-series data from its microservices and processes to the integrated Prometheus collector.

It allows you to define metric profiles, create individual metrics, and associate those metrics with specific metric profile.

RBFS time-series metric configurations at a high level:

- **Metric Profile Configuration**: Define common settings that include scrape interval and append timestamp for a group of metrics.
- **Metric Configuration**: Configure the parameters of the metrics which are to be collected and exported. It includes the BDS table that contains the operational state to be converted into a time-series. You can define attributes, filters, and labels. They help in tagging, querying, filtering, and grouping the data in the time-series database.

    Attribute Configuration (Mandatory): Define the BDS attributes that will be exported.

    Define Filters (Optional): Filters the BDS objects which are going to be exported based on defined criteria. This is required when the BDS table contains more than one object.

    Define Labels (Optional): It identifies and clarifies time services coming from different BDS objects by labeling them with metadata. Allows for querying, grouping, and filtering in time-series data.

- **Alert Configuration**: Inform about specific conditions in the system based on the captured metrics.
- **Alert Profile Configuration**: Group multiple alerts into a single profile by applying notification rules to alerts with similar characteristic.
- **Enabling Data History Retention**: Option for debugging. If enabled, BDS logs the BDS queries that were executed to retrieve the telemetry data from BDS.
- **Enabling Prometheus Self Monitoring**: Prometheus can monitor its own health state.
- **Monitoring Daemon Status**: Monitor the status of system daemons (processes), specifically to track whether they are operational or not.



In previous releases, there was a built-in Prometheus 'UP' metric to monitor the status of the daemon and determine whether it was up or down. However, this built-in functionality is no longer available. You can now define your own custom metric to achieve the same monitoring capabilities.

Configuration Hierarchy

The diagram illustrates the Prometheus configuration hierarchy.

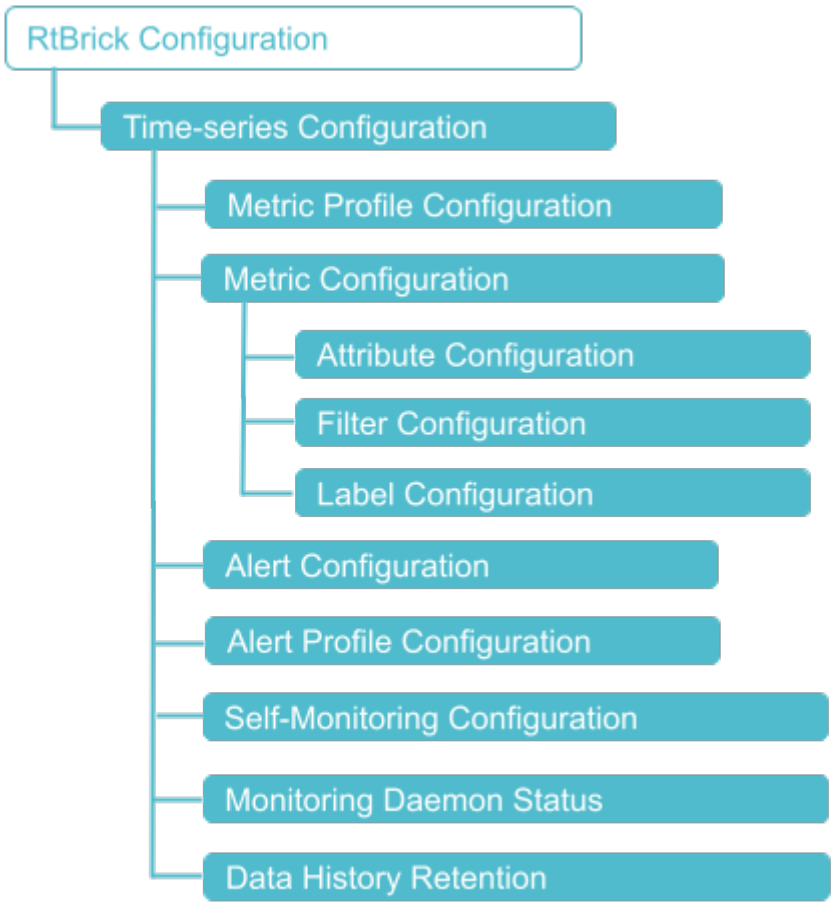


Figure 159. TSDB Configuration Hierarchy

Configuration Syntax and Commands

The following sections describe the time-series configuration syntax and commands.

Guidelines for Naming

Metric and Metric Profile names must not start with "rtbrick," as this name is reserved for internal use. Also, RBFS has built-in default metric profile; therefore, the custom metric profile names must not be "default".

Metric Configuration

Metric configuration is used to configure the operational state which is to be exported.



- RBFS time-series configuration may differ from device to device; however, the exported metrics should remain consistent because the characteristics of these metrics will be

the same across all platforms. For example, while the names of the chassis thermal sensors may vary from platform to platform, the underlying metric will consistently be the chassis temperature metric.

- Every metric must be attached to a metric profile. If you do not explicitly associate a metric with a profile, it will automatically be assigned to the default metric profile.

Syntax:

set time-series metric <name> <option> <value>

Attribute	Description
metric_name	Name of the metric. See Naming Conventions.
append-timestamp <true | false>	Set the append-timestamp to true for exporting the metric values with timestamp. By default, the value is 'false'. The timestamp is the epoch represented in milliseconds, and its value corresponds to the creation time of the current metrics in RBFS.
attribute	Specifies the name of the attribute in the target table which is to be scraped and exported.
bds-type <object-metric | index-metric>	Specifies the type of metric, that is scraped and exported. There are two types, object-metric and index-metric. • object-metric: Object metrics are scraped from the BDS objects. • index-metric: Index metrics are scraped from the table index.

Attribute	Description
metric_type	• gauge: A gauge is a metric that represents a single numerical value that can fluctuate up and down. Gauges are commonly used to measure values such as temperature or current memory usage, as well as "counts" that can increase or decrease, like the number of concurrent requests. • counter: A cumulative metric that represents a single value that only increases over time or resets to zero upon a restart. It is ideal for tracking quantities such as the number of requests served, tasks completed, or errors encountered.  Do not use a counter to expose values that can decrease. Counters are strictly for values that only increase or reset on restart. Use gauge for metrics that may increase or decrease.
description	Description for the metric. Allowed range of 128 characters.
filter <match-attribute-name>	Specifies the matching attribute name for the filter.
include-subscribed-tables <true | false>	Specifies whether the configuration needs to be applied on a subscribed tables as well. Default: false.
index-name	Specifies the index-name if the 'bds_metric_type' is index-metric. This is applicable for index-metric only.
prometheus-type <counter | gauge>	Configures the Prometheus metric type. Currently, the supported Prometheus metric types are 'counter' and 'gauge'.
table-name	Specifies the target table from which the data is scraped and exported (can be a regular expression).

API To access the RESTCONF API that corresponds to this CLI, click here.

Example:

This configuration is used to export fan speed telemetry data from the sensor table for only chassis fans. It defines a time-series metric named 'chassis_fan_speed_rpm' for telemetry that captures chassis fan speed (in RPM) from a sensor table called global.chassis_0.resource.sensor.fan (which contains sensor data, including fans).

The 'bds-type' is defined as 'object-metric', which means the metric is based on object-like data entries in the table. The 'prometheus-type' is specified as 'gauge', that is for numeric values that can go up or down. The description for the metric is added as 'Chassis fan speed in rpm'.

A filter is applied to the 'resource_name' column, with the 'match-attribute-value' set to 'Chassis'. The match-type is defined as 'regular-expression'. This filter determines which rows in the source table (global.chassis_0.resource.sensor.fan) will be included when generating this metric. It specifically matches rows where the value of 'resource_name' satisfies the regular expression for 'Chassis'.

Also, a second filter is applied to the 'resource_type', which only includes rows where the value is exactly 'fan'. It ensures an exact string match. This makes sure that only fan-related resource entries are considered and filtered out irrelevant sensors.

```
set time-series metric chassis_fan_speed_rpm
set time-series metric chassis_fan_speed_rpm table-name
global.chassis_0.resource.sensor.fan
set time-series metric chassis_fan_speed_rpm include-subscribed-tables false
set time-series metric chassis_fan_speed_rpm bds-type object-metric
set time-series metric chassis_fan_speed_rpm prometheus-type gauge
set time-series metric chassis_fan_speed_rpm description "Chassis fan speed in
rpm"
set time-series metric chassis_fan_speed_rpm filter resource_name
set time-series metric chassis_fan_speed_rpm filter resource_name match-attribute-
value Chassis
set time-series metric chassis_fan_speed_rpm filter resource_name match-type
regular-expression
set time-series metric chassis_fan_speed_rpm filter resource_type
set time-series metric chassis_fan_speed_rpm filter resource_type match-attribute-
value fan
set time-series metric chassis_fan_speed_rpm filter resource_type match-type exact
set time-series metric chassis_fan_speed_rpm attribute rpm
set time-series metric chassis_fan_speed_rpm attribute rpm label fan
set time-series metric chassis_fan_speed_rpm attribute rpm label fan label-value
resource_name
set time-series metric chassis_fan_speed_rpm attribute rpm label fan label-type
dynamic
```

Example:

```
supervisor@rtbrick.net: cfg> show config time-series metric chassis_fan_speed_rpm
{
  "rtbrick-config:metric": [
    {
      "name": "chassis_fan_speed_rpm",
      "table-name": "global.chassis_0.resource.sensor",
      "bds-type": "object-metric",
      "prometheus-type": "gauge",
      "description": "Chassis fan speed in rpm",
      "filter": [
        {
          "match-attribute-name": "resource_name",
          "match-attribute-value": "CHASSIS.*",
          "match-type": "regular-expression",
          "match-negate": "false"
        },
        {
          "match-attribute-name": "resource_type",
          "match-attribute-value": "fan",
          "match-type": "exact",
          "match-negate": "false"
        }
      ],
      "attribute": [
        {
          "attribute-name": "rpm",
          "label": [
            {
              "label-key": "fan",
              "label-value": "resource_name",
              "label-type": "dynamic"
            },
            {
              "label-key": "status",
              "label-value": "status_code",
              "label-type": "dynamic"
            }
          ]
        }
      ]
    }
  ]
}
```

Example for Index Metric Configuration

The following is an example for index metric configuration.

This configuration defines a time-series metric called 'local_bds_statistics.' It retrieves data from the source table named 'local.bds.statistics.' The 'bds-type' is classified as an index-metric, indicating that this metric is based on an index. The Prometheus type is specified as 'counter,' which means this is a counter metric. The 'index-name' is set to 'immutable-index.'

The attribute 'active-entry-count' is defined to specify a particular attribute from the source table that will be included in the metric. Labels are assigned to indicate the attributes. This configuration enables the export of the 'active-entry-count' from the 'local.bds.statistics' table into Prometheus as a counter-type metric, tagged with a static label and indexed using the immutable index.

```
set time-series metric local_bds_statistics
set time-series metric local_bds_statistics table-name local.bds.statistics
set time-series metric local_bds_statistics bds-type index-metric
set time-series metric local_bds_statistics prometheus-type counter
set time-series metric local_bds_statistics index-name immutable-index
set time-series metric local_bds_statistics description "This metric is exported
from local.bds.statistics by all BDs"
set time-series metric local_bds_statistics attribute active-entry-count
set time-series metric local_bds_statistics attribute active-entry-count label
active_entry_count
set time-series metric local_bds_statistics attribute active-entry-count label
active_entry_count label-value active_entry_count
set time-series metric local_bds_statistics attribute active-entry-count label
active_entry_count label-type static
```

```
supervisor@rtbrick.net: cfg> show config time-series metric local_bds_statistics
{
  "rtbrick-config:metric": [
    {
      "name": "local_bds_statistics",
      "table-name": "local.bds.statistics",
      "bds-type": "index-metric",
      "prometheus-type": "counter",
      "index-name": "immutable-index",
      "description": "This metric is exported from local.bds.statistics by all
BDs",
      "attribute": [
        {
          "attribute-name": "active-entry-count",
          "label": [
            {
              "label-key": "active_entry_count",
              "label-value": "active_entry_count",
              "label-type": "static"
            }
          ]
        }
      ]
    }
  ]
}
```

Example Metric Configuration for Monitoring Daemon Status

This configuration defines a metric named process_status, which extracts data from a specific internal system table called global.process.status. The BDS type is

defined as object-metric, indicating that the metric is derived from an object table. In the configuration, the metric type is specified as a gauge. It indicates increase or decrease, for example 1 for UP and 0 for DOWN.

The description provided is "testing UP metrics." The main attribute is defined as operational_status, and its values will be exported as part of the metric from the table. Additionally, the configuration introduces a label called administrative_state for the metric. The value for this label will be sourced from the admin_status column in the same row of the table. It is marked as dynamic, meaning the label value can vary at runtime for each row of data.

```
set time-series metric process_status
set time-series metric process_status table-name global.process.status
set time-series metric process_status bds-type object-metric
set time-series metric process_status prometheus-type gauge
set time-series metric process_status description "monitor daemon status metrics"
set time-series metric process_status attribute operational_status
set time-series metric process_status attribute operational_status label
administrative_state
set time-series metric process_status attribute operational_status label
administrative_state label-value admin_status
set time-series metric process_status attribute operational_status label
administrative_state label-type dynamic
set time-series metric process_status attribute operational_status label bd
set time-series metric process_status attribute operational_status label bd label-
value process
set time-series metric process_status attribute operational_status label bd label-
type dynamic
```

Example:

```
{
  "rtbrick-config:metric": [
    {
      "name": "process_status",
      "table-name": "global.process.status",
      "bds-type": "object-metric",
      "prometheus-type": "gauge",
      "description": "monitor daemon status metrics",
      "attribute": [
        {
          "attribute-name": "operational_status",
          "label": [
            {
              "label-key": "administrative_state",
              "label-value": "admin_status",
              "label-type": "dynamic"
            },
            {
              "label-key": "bd",
              "label-value": "process",
              "label-type": "dynamic"
```

```
            }
          ]
        }
      ]
    }
  ]
}
```

To access the RESTCONF API that corresponds to this CLI, click here.

Metric Attributes

Attributes are used for extracting specific values from the table data.

The number of labels is limited to 50 labels per metric.

Metric Filters

Filters allow you to include or exclude specific BDS objects based on the objects attributes.

The list of attribute filters determines which table rows are included in metric generation. All filters in this list must match to generate the metric, so the list functions as an implicit AND.

Metric Labels

Labels are key-value metadata on metrics. For example, it adds related labels such as CPU ID, interface name, and so on.

Each unique combination of key-value label pairs creates a new time series, which can significantly increase the amount of data stored. Avoid using labels to represent dimensions with high cardinality, such as user IDs, email addresses, or other sets of values that can vary widely.

To access the RESTCONF API that corresponds to this CLI, click here.

Tracking Invalid Time-series Configurations

RBFS offers functionality to track invalid time-series configurations that cause runtime issues. For example, when Prometheus reports duplicate time-series data due to wrong labels.

You can view the list of misconfiguration using the show command:

```
show time-series metric rtbrick_invalid_metric_config
```

There are six error types for invalid configurations in RBFS:

Error Type	Description
Error Type 1: *invalid_filter*	This error occurs due to a invalid filter name. If the configured filter attribute is not present in the table, this error is shown. If this error occurs, the filter does not have any effect, and there may be many objects get exported.
Error Type 2: *invalid_attribute*	This error occurs due to a invalid attribute name. If the configured attribute is not present in the table, then this error is shown. If this error occurs, the expected metric does not appear as the configured attribute does not exist.
Error Type 3: *invalid_attribute_type*	This error occurs due to a invalid type of attribute. If the configured attribute is present in the table and if the datatype is wrong, then this error is shown. if this error occurs, the expected metric does not show up, because the attribute does not contain a numeric value or its value cannot be converted into a numeric value.
Error Type 4: *invalid_label*	This error occurs due to a invalid key name. If the configured label attribute is not present in the table, then this error is shown. If this error occurs, Prometheus may process duplicate time-series entries due to missing labels. Filtering time-series does not work.

Error Type	Description
Error Type 5: *invalid_label_attribute_type*	This error occurs due to a invalid label attribute type. If the configured label attribute is present in the table and if the datatype is wrong, this error is shown. the configured label attribute is not present in the table, then this error is shown. If this error occurs, Prometheus may process duplicate time-series entries due to missing labels. Filtering time-series does not work.
Error Type 6: *invalid_filter_attribute_type*	This error occurs due to a invalid filter attribute type. If the configured filer attribute is present in the table and if the datatype is wrong, this error is shown.

The following sections provide examples for various error types with invalid configurations:

Error Type 1: Invalid Filter

In this configuration, the filter name 'invalid_filter' is used as a key instead of specifying a valid attribute. So, this is not a valid configuration.

```
set time-series metric bgp_default_peer_state filter invalid_filter
set time-series metric bgp_default_peer_state filter invalid_filter match-
attribute-value Active
set time-series metric bgp_default_peer_state filter invalid_filter match-type
exact
```

```
supervisor@rtbrick.net: cfg> show config time-series metric bgp_default_peer_state
filter invalid_filter
{
  "rtbrick-config:filter": [
    {
      "match-attribute-name": "invalid_filter",
      "match-attribute-value": "Active",
      "match-type": "exact"
    }
  ]
}
```

Error Type 2: Invalid Attribute

In this configuration 'invalid_attribute' is not a valid attribute for the metric 'bgp_default_peer_state'. So, this is not a valid configuration.

```
set time-series metric bgp_default_peer_state attribute invalid_attribute
```

```
supervisor@rtbrick.net: cfg> show config time-series metric bgp_default_peer_state
attribute invalid_attribute
{
  "rtbrick-config:attribute": [
    {
      "attribute-name": "invalid_attribute"
    }
  ]
}
```

Error Type 3: Invalid Attribute Type

In this configuration, though 'af_configured' exists, it is not of a supported data type for metrics. So, this is not a valid configuration.

```
set time-series metric bgp_default_peer_state attribute af_configured
```

```
supervisor@rtbrick.net: cfg> show config time-series metric bgp_default_peer_state
attribute af_configured
{
  "rtbrick-config:attribute": [
    {
      "attribute-name": "af_configured"
    }
  ]
}
```

Error Type 4: Invalid Label

In this configuration the 'invalid_label' is not a valid label key. So this is not a valid configuration.

```
set time-series metric bgp_default_peer_state attribute state label invalid_label
```

```
{
  "rtbrick-config:label": [
    {
      "label-key": "invalid_label",
```

```
      "label-value": "invalid_label",
      "label-type": "dynamic"
    }
  ]
}
```

Error Type 5: Invalid Label Type

error type5: invalid_label_attribute_type

In this configuration, the label value ('af_configured') has a data type that is not allowed for label values. So this is not a valid configuration.

```
set time-series metric bgp_default_peer_state attribute state label
invalid_label_type
set time-series metric bgp_default_peer_state attribute state label
invalid_label_type label-value af_configured
set time-series metric bgp_default_peer_state attribute state label
invalid_label_type label-type dynamic
```

```
supervisor@rtbrick.net: cfg> show config time-series metric bgp_default_peer_state
attribute state label invalid_label
_type
{
  "rtbrick-config:label": [
    {
      "label-key": "invalid_label_type",
      "label-value": "af_configured",
      "label-type": "dynamic"
    }
  ]
}
```

Error Type 6: Invalid Filter Attribute Type

error type5: invalid_filter_attribute_type

In this configuration, the filter value ('af_configured') has a data type that is not allowed for filter values. So this is not a valid configuration.

```
set time-series metric bgp_default_peer_state filter af_configured
set time-series metric bgp_default_peer_state filter af_configured match-
attribute-value ipv4-unicast
set time-series metric bgp_default_peer_state filter af_configured match-type
exact
```

```
supervisor@rtbrick.net: cfg> show config time-series metric bgp_default_peer_state
filter af_configured
```

```
{
  "rtbrick-config:filter": [
    {
      "match-attribute-name": "af_configured",
      "match-attribute-value": "ipv4-unicast",
      "match-type": "exact"
    }
  ]
}
```

To see show command output for the error types for invalid configurations, see the section Show Command Output for Invalid Metric Configuration

Metric Profile Configuration

In a metric profile, you can club a collection of related metrics, which can be managed and exported together.

You can create a metric profile and associate a individual metric with the profile. It allows you to define a common setting such as scrape interval and append-timestamp for a group of metrics. This common settings will be applied automatically to all associated metrics. You can configure a maximum of 100 metric profiles.



If you do not configure a Metric Profile, the system will use a default metric profile with a predefined scrape interval.

Syntax:

set time-series metric-profile <profile-name> **scrape-interval** <scrape-interval>

Attribute	Description
profile-name	Specify the name of the profile. Note: Metric Profile names must not begin with the name 'rtbrick' as it is reserved for internal use. Similarly, RBFS has built-in default metric profiles, therefore, do not use the name 'default' as metric profile name.
scrape-interval	The frequency (period of time) at which the system fetches (scrapes) data from a target source.
append-timestamp	Add a time-stamp on every metric pulled.

Example:

This configuration defines a metric profile called "up_metrics." The configuration sets the scrape interval to 10 seconds, meaning that metrics linked to this metric profile will be collected every 10 seconds.

```
set time-series metric-profile up_metrics
set time-series metric-profile up_metrics scrape-interval 10s
```

Example:

```
{
  "rtbrick-config:metric-profile": [
    {
      "profile-name": "up_metrics",
      "scrape-interval": "10s"
    }
  ]
}
```

Attaching a Metric with a Metric Profile

You can associate an existing metric with an existing metric profile.

Syntax:

set time-series metric <metric-name> **profile-name** <profile-name>

Attribute	Description
<metric-name>	Specify the metric name.
<profile-name>	Specify the metric profile name.

API To access the RESTCONF API that corresponds to this CLI, click here.

The following command is used to associate a metric named 'process_status' with the metric profile named 'up_metrics'.

```
set time-series metric process_status profile-name up_metrics
```

Example:

```
supervisor@rtbrick.net: cfg> show config time-series metric process_status
profile-name
{
  "rtbrick-config:profile-name": "up_metrics"
}
```

Alert Configuration

You can configure alerts which are notifications about the events based on the captured metrics.



Alerts cannot be assigned to an alert profile. It is the alert profiles that are used to forward alerts. For each alert, the system will utilize the first matching profile from the list of available alert profiles. The priority attribute of each profile determines the order in which alerts are processed.

Syntax

set time-series alert-profile <profile-name> <attribute> <value>

Attribute	Description
annotations	Key-value pairs that add metadata to the alert.
description	Alert description.
expr	PromQL Alert evaluation. It defines condition for triggering this alert.
for	Specifies the duration the condition must be true before triggering the alert.
group	Logical grouping of alerts.
interval	Defines how often this alert expression (expr) is evaluated (for example, every 30s, 1m, and so on).
labels	Key-value pairs used to categorize alerts, mainly for routing in Alertmanager.
level	Alert's severity level.
summary	Explicit annotation label summary.

To access the RESTCONF API that corresponds to this CLI, click here.

Example:

This configuration defines a time-series alert named 'chassis_fan_failure', which monitors the speed of chassis fans using time-series metrics. The alert continuously checks fan speeds and triggers if the fan speed remains below 1500 RPM for 5 consecutive minutes, with checks occurring every minute. It is organized under the group labeled "fans," which categorizes similar alerts.

The alert is assigned a severity level of 2 and the label "repeat_interval" is set to 24 hours, meaning the alert will not be resent more than once within that timeframe. Additional annotations include metadata such as the threshold (1500 RPM), the unit, the actual fan speed at the time of the alert, and the direction (below).

The alert only triggers if the condition holds true for a continuous 5-minute period. Specifically, it checks whether the maximum fan speed (in RPM) over the last 60 seconds is less than 1500. This alert serves to monitor for any fan failures, and if the speed is below the threshold for 5 minutes, it will trigger an alert.

```
set time-series alert chassis_fan_failure
set time-series alert chassis_fan_failure group fans
set time-series alert chassis_fan_failure for 5m
set time-series alert chassis_fan_failure interval 1m
set time-series alert chassis_fan_failure expr
"max_over_time(chassis_fan_speed_rpm[60s]) < 1500"
set time-series alert chassis_fan_failure level 2
set time-series alert chassis_fan_failure summary "Fan speed {{$value}}rpm of fan
{{$labels.fan}} is below 1500rpm."
set time-series alert chassis_fan_failure description "Fan speed is below 1500rpm"
set time-series alert chassis_fan_failure labels repeat_interval:24h
set time-series alert chassis_fan_failure annotations threshold:1500
set time-series alert chassis_fan_failure annotations unit:RPM
set time-series alert chassis_fan_failure annotations value:{{$value}}
set time-series alert chassis_fan_failure annotations "direction: below"
```

Example:

```
supervisor@rtbrick.net: cfg> show config time-series alert chassis_fan_failure
{
  "rtbrick-config:alert": [
    {
      "name": "chassis_fan_failure",
      "group": "fans",
      "for": "5m",
      "interval": "1m",
      "expr": "max_over_time(chassis_fan_speed_rpm[60s]) < 1500",
      "level": "2",
```

```
      "summary": "Fan speed {{$value}}rpm of fan {{$labels.fan}} is below
1500rpm.",
      "description": "Fan speed is below 1500rpm",
      "labels": [
        "repeat_interval:24h"
        ],
      "annotations": [
        "threshold:1500",
        "unit:RPM",
        "value:{{$value}}",
        "direction: below"
        ]
    }
  ]
}
```

Alert Profile Configuration

You can set up alert profiles for Prometheus time-series data. This configuration defines alerts, how alerts should be grouped, filtered, and repeated.

Syntax

set time-series alert-profile <profile-name> <attribute> <value>

Attribute	Description
profile-name	Specify the name of the alert profile.
priority	Specify the priority number.
group-by	Groups alerts by one or more labels.
matchers	Filters which alerts are processed by this profile.
repeat-interval	Defines how frequently notifications for unresolved alerts will be resent.

API To access the RESTCONF API that corresponds to this CLI, click here.

The following configuration defines a time-series alert profile named '4h_receiver'. This profile specifies how alerts that meet certain criteria should be managed.

The priority level is set to '1', indicating that this alert profile has high priority, as lower numbers indicate higher preference. The 'repeat-interval' is configured for '4h', meaning that alerts associated with this profile will be resent every 4 hours if they remain active. In essence, alerts under this profile are sent once every 4

hours.

The 'matchers' parameter is defined as 'repeat_interval=4h', which filters the alerts to which this profile applies. Only alerts with the label 'repeat_interval=4h' will be managed by this profile.

```
set time-series alert-profile 4h_receiver
set time-series alert-profile 4h_receiver priority 1
set time-series alert-profile 4h_receiver repeat-interval 4h
set time-series alert-profile 4h_receiver matchers repeat_interval=4h
```

```
{
  "rtbrick-config:alert-profile": [
    {
      "profile-name": "4h_receiver",
      "priority": 1,
      "repeat-interval": "4h",
      "matchers": [
        "repeat_interval=4h"
        ]
    }
  ]
}
```

Enabling Time-series Query History

All BDS queries related to time-series exposure will be logged in a BDS table for review during issue debugging. By default, time series database history is disabled.

Syntax

set time-series history-status [enable | disable]

Attribute	Description
[enable|disable]	Enable time series database history by specifying 'enable'. Time-series database history is disabled, by default.

Example:

The following configuration enables timeseries history status by specifying 'enable'.

```
set time-series history-status enable
```

```
supervisor@rtbrick.net: cfg> show config time-series history-status
{
  "rtbrick-config:history-status": "enable"
}
```

Prometheus Self-Monitoring Configuration

You can enable a self-monitoring feature that allows Prometheus to monitor its own performance and health. This self-monitoring functionality collects metrics regarding the system's operation, such as query performance and resource usage. The scrape interval determines how often these metrics are collected.

Syntax:

set time-series self-monitoring enable <false|true> **set time-series self-monitoring scrape-interval** <scrape-interval[1-128]>

Attribute	Description
enable <false | true>	Specify true to enable the self monitoring functionality for Prometheus.
<scrape-interval[1-128]>	The frequency (period of time) at which the system fetches (scrapes) data from a target source.

API To access the RESTCONF API that corresponds to this CLI, click here.

Example:

The following CLI commands enable the self-monitoring capability for the time-series database. The self monitoring is enabled by specifying 'true'. The scrape-interval is defined as 10s. It means the metrics are collected every 10 seconds.

```
set time-series self-monitoring enable true
set time-series self-monitoring scrape-interval 10s
```

Example:

```
{
```

```
  "rtbrick-config:self-monitoring": {
    "enable": "true",
    "scrape-interval": "10s"
  }
}
```

Enabling Append-Timestamp in Prometheus

RBFS supports 'append-timestamp' functionality in Prometheus. When the append-timestamp flag is set, the first metric generated after an object is updated will include the actual timestamp of the update. This accurately reflects when the change took place. For all subsequent metrics for the same object (since it has not been been updated again) the current scrape time will be used.

You can enable append-timestamp on both metric or metric profile level. If you configure append-timestamp for both, metric-level gets priority.

Syntax:

set time-series metric <metric-name> **append-timestamp** <false|true>
set time-series metric-profile <profile-name> **append-timestamp** <false|true>

Attribute	Description
<metric-name>	Name of the metric.
<profile-name>	Name of the metric profile.
append-timestamp <false / true>	Specify true to enable time-stamp functionality.

Example command:

The following command is used to add a timestamp to each metric associated with the metric profile called 'chassis'.

```
set time-series metric-profile chassis append-timestamp true
```

Example:

```
{
```

```
  "rtbrick-config:metric-profile": [
    {
      "profile-name": "chassis",
      "append-timestamp": "true"
    }
  ]
}
```

10.1.3. Observability Operational Commands

Show Commands

High-level time-series show command and options:

```
supervisor@rtbrick.net: cfg> show time-series
 alert
 metric
 statistics
```

Alert Details

Display information about the time-series alerts.

Syntax:

show time-series alert <alert-name>

Option	Description
-	Without any option, the command lists all firing alerts.
<alert-name>	All alerts for the given alert rule.
pipe (|)	Allows you to specify options: grep and count.
grep <grep_str>	Specify the grep string.

Example: Information about time-series alert

```
supervisor@rtbrick.net: cfg> show time-series alert
State       Since                  Level        Summary
firing      26-JUN-2025 09:40:24   Critical     Process confd has crashed.
```

Example:

```
supervisor@rtbrick.net: cfg> show time-series alert | count
3
```

Metric Details

Display information about timeseries metrics.

Syntax:

show time-series metric <metric-name>

Option	Description
-	Without any option, displays information about all metrics.
rtbrick_invalid_metric_config	Displays the list of misconfigurations in time-series.

Example: Information for a specified metric.

```
supervisor@rtbrick.net: cfg> show time-series metric process_status
Metric: process_status
  Value: 1 sampled at 23-JUN-2025 10:20:08
  Labels:
    administrative_state          : UP
    bd                            : bgp.appd.1
    bd_name                       : etcd
    element_name                  : L1-STD-2-2008
    instance                      : localhost:1002
    job                           : bds_up_metrics
    pod_name                      : rtbrick-pod

  Value: 1 sampled at 23-JUN-2025 10:20:08
  Labels:
    administrative_state          : UP
    bd                            : bgp.iod.1
    bd_name                       : etcd
    element_name                  : L1-STD-2-2008
    instance                      : localhost:1002
    job                           : bds_up_metrics
    pod_name                      : rtbrick-pod

  Value: 1 sampled at 23-JUN-2025 10:20:08
  Labels:
    administrative_state          : UP
    bd                            : confd
    bd_name                       : etcd
    element_name                  : L1-STD-2-2008
    instance                      : localhost:1002
```

```
    job                          : bds_up_metrics
    pod_name                     : rtbrick-pod

  Value: 1 sampled at 23-JUN-2025 10:20:08
  Labels:
    administrative_state         : UP
    bd                           : fibd
    bd_name                      : etcd
    element_name                 : L1-STD-2-2008
```

Invalid Metric Configuration

Example for invalid metric configurations

NOTE:

In the output (as shown below), if the displayed 'value' continues to increase (incremental) with each subsequent output, it indicates that the issue is still unresolved. If the 'value' remains static (no longer increasing) in the subsequent outputs, it indicates that the issue has been resolved.

```
supervisor@rtbrick.net: cfg> show time-series metric rtbrick_invalid_metric_config
Metric: rtbrick_invalid_metric_config

  Value: 3 sampled at 30-JUL-2025 06:45:10
  Labels:
    attribute_name               : af_configured
    bd_name                      : bgp.iod.1
    element_name                 : L1-STD-1-1047
    error_type                   : invalid_attribute_type
    instance                     : localhost:3102
    job                          : bds_rtbrick_error
    metric_name                  : bgp_default_peer_state
    pod_name                     : rtbrick-pod
    profile_name                 : bgp_metrics

  Value: 21 sampled at 30-JUL-2025 06:45:10
  Labels:
    attribute_name               : af_configured
    bd_name                      : bgp.iod.1
    element_name                 : L1-STD-1-1047
    error_type                   : invalid_label_attribute_type
    instance                     : localhost:3102
    job                          : bds_rtbrick_error
    metric_name                  : bgp_default_peer_state
    pod_name                     : rtbrick-pod
    profile_name                 : bgp_metrics

  Value: 3 sampled at 30-JUL-2025 06:45:10
  Labels:
    attribute_name               : af_configured
    bd_name                      : bgp.iod.1
    element_name                 : L1-STD-1-1047
    error_type                   : invalid_filter_attribute_type
```

```
    instance                      : localhost:3102
    job                           : bds_rtbrick_error
    metric_name                   : bgp_default_peer_state
    pod_name                      : rtbrick-pod
    profile_name                  : bgp_metrics

  Value: 3 sampled at 30-JUL-2025 06:45:10
  Labels:
    attribute_name                : invalid_label
    bd_name                       : bgp.iod.1
    element_name                  : L1-STD-1-1047
    error_type                    : invalid_label_attribute
    instance                      : localhost:3102
    job                           : bds_rtbrick_error
    metric_name                   : bgp_default_peer_state
    pod_name                      : rtbrick-pod
    profile_name                  : bgp_metrics

  Value: 3 sampled at 30-JUL-2025 06:45:10
  Labels:
    attribute_name                : invalid_filter
    bd_name                       : bgp.iod.1
    element_name                  : L1-STD-1-1047
    error_type                    : invalid_filter_attribute
    instance                      : localhost:3102
    job                           : bds_rtbrick_error
    metric_name                   : bgp_default_peer_state
    pod_name                      : rtbrick-pod
    profile_name                  : bgp_metrics

  Value: 3 sampled at 30-JUL-2025 06:45:10
  Labels:
    attribute_name                : invalid_attribute
    bd_name                       : bgp.iod.1
    element_name                  : L1-STD-1-1047
    error_type                    : invalid_attribute
    instance                      : localhost:3102
    job                           : bds_rtbrick_error
    metric_name                   : bgp_default_peer_state
    pod_name                      : rtbrick-pod
    profile_name                  : bgp_metrics
```

Time-series Statistics

The show time-series statistics that provides visibility into the time-series processing on RBFS. It helps to identify any existing configuration errors and displays the number of active jobs currently, running to collect time-series data. The number of active jobs depends on the applied time-series metric configuration.

Syntax:

show time-series statistics

Option	Description
-	Without any option, the command displays all statistics.
pipe (|)	Allows you to specify options: grep and count.
grep <grep_str>	Specify the grep string.

Example: Time-series statistics

```
supervisor@rtbrick.net: cfg> show time-series statistics
Scrape Targets
Metric Profile                        Daemons
bgp_metrics                           1
rtbrick_error                         1
up_metrics                            1

Error Counters
Name                                                                Count
Increase (in last 5 mins)
prometheus_target_scrapes_sample_duplicate_timestamp_total          0           0
prometheus_target_scrapes_exemplar_out_of_order_total               0           0
prometheus_target_scrapes_sample_out_of_bounds_total                0           0
prometheus_target_scrapes_sample_out_of_order_total                 0           0
prometheus_target_scrapes_exceeded_sample_limit_total               0           0
supervisor@L1-STD-2-2008>bm08-tst.hel.rtbrick.net: cfg>
```

10.2. Resmon

10.2.1. Resource Monitoring Overview

Monitoring the system resources is very crucial to analyze the health of devices. RBFS has dedicated daemons peripherald and resmond to discover and monitor the device resources.

RBFS Resource Monitoring functionality provides support for monitoring the following components:

- CPU
- Memory
- Processes

- Disks
- Sensor
- Transceivers

CPU

RBFS Resource Monitoring framework collects CPU hardware information from the global.chassis_0.resource.cpu table. In addition, it calculates CPU usage dynamically and stores this information in the global.chassis_0.resource.cpu_usage table.

Memory

RBFS Resource Monitoring feature collects RAM hardware information from the global.chassis_0.resource.mem table. It also gathers memory usage information in the global.chassis_0.resource.mem_usage table.

Processes

RBFS Resource Monitoring feature collects process usage information of Brick Daemon(BD) that runs in the RBFS and stores the information in the global.chassis_0.resource.proc_usage table. It dynamically gathers the process information and calculates the CPU and the memory usage of the individual Brick Daemons.

Disks

RBFS Resource Monitoring feature collects the disk information from the global.chassis_0.resource.disk table. It also collects disk usage information in the global.chassis_0.resource.disk_usage table.

Sensor

RBFS Resource Monitoring feature the reading data of the hardware sensor such as temperature, fan, power-supply, and system LED. The data collected from the sensor are stored in the following tables for the different components:

- global.chassis_0.resource.sensor.chassis
- global.chassis_0.resource.sensor.psu

- global.chassis_0.resource.sensor.fan
- global.chassis_0.resource.sensor.thermal
- global.chassis_0.resource.sensor.led



The RBFS implementation supports pluggable transceiver modules on white box switches only.

System Clock

RBFS Resource Monitoring feature provides support for monitoring the system clock so that the system clock is always in sync with the NTP server clock. This ensures that the deviation from the NTP server clock always remains within acceptable limits. It collects the system clock information from the global.os.timex table.



The RBFS implementation supports pluggable transceiver modules on white box switches only.

Transceivers

RBFS Resource Monitoring feature monitors transceivers plugged onto the chassis. It reads transceivers EEPROM (Electrically Erasable Programmable Read-Only Memory) data and translates the data to respective fields in the BDS tables.

RBFS provides the following functionalities for monitoring transceivers:

- Mechanism to discover and monitor transceiver modules. Supported transceiver modules include SFP, SFP+, QSFP, QSFP+, and QSFP28 (DAC is not supported).
- Provides CLIs to write to transceivers
- Provides show commands to see transceiver inventory and status of each module
- Logs the status of the transceivers



The RBFS implementation supports monitoring of pluggable transceiver modules on white box switches only.

RBFS Resource Monitoring feature performs the following tasks:

- Transceiver: Identifying the following brief information of a discovered transceiver module and stores in table global.transceiver.

    ifp_name

    module_type

    vendor_name

    vendor_serial

    vendor_part_number

- Read the following transceiver data from a module and stores in the table: global.transceiver.lane.

    RX/TX alarming (loss of light and loss of signal)

- RX/TX power status

    Voltage and BIAS status

    Temperature

- Write the transceiver data to an transceiver module

    Enabling high power class on QSFP28

    Shutdown lasers (QSFP28, SFP+ and SFP)

Logging

RBFS Resource Monitoring feature can log the following transceiver module events:

- Temperature high alarm
- Temperature high warning
- Temperature low alarm
- Temperature low warning
- Voltage high alarm
- Voltage high warning
- Voltage low alarm
- Voltage low warning
- Lane power high alarm

- Lane power high warning
- Lane power low alarm
- Lane power low warning
- Lane bias high alarm
- Lane bias high warning
- Lane bias low alarm
- Lane bias low warning

Q2C Resource Monitoring

Q2C platform resource-specific usage metrics are stored in the BDS table: local.bcm.resource.monitor. Resource usage information enables you to understand the scale of services that the device performs and how it optimally leverages the resource usage.

The following table provides the list of supported resource types for monitoring in RBFS for Q2C platforms.

Resource Type	Description
EEDB_ARP	EEDB is an Egress Encapsulation Data Base. This resource is consumed when ARP (Address Resolution Protocol) entries.
EEDB_L2TP	EEDB is an Egress Encapsulation Data Base. This resource is consumed when L2TP subscribers are created in hardware.
EEDB_MPLS_TUNNEL	EEDB is an Egress Encapsulation Data Base. This resource is consumed when MPLS tunnels are created in the chip.
EEDB_PPPOE	EEDB_PPPOE is used for PPPoE encapsulation. This resource is consumed when PPPoE subscribers are created in hardware.
EEDB_PWE	This resource is consumed when L2X or cross-connection sessions are created in hardware at egress.

Resource Type	Description
IN_LIF_FORMAT_PWE	This resource is consumed when a pseudowire is created in the hardware at ingress.
IN_AC_C_C_VLAN_DB	This resource is consumed when an ingress logical interface for double-tagged VLAN is created.
IN_AC_C_VLAN_DB	This resource is consumed when an ingress logical interface for single tag VLAN is created.
IN_AC_UNTAGGED_DB	This resource is consumed when an ingress logical interface for untagged IFLs is created.
IPV4_MULTICAST_PRIVATE_LPM_FORWARD	LPM stands for Longest Prefix Match. This resource is consumed for multicast (source, group) entries.
IPV4_UNICAST_PRIVATE_LPM_FORWARD	This resource is consumed for both default and non-default VRF instance IPv4 prefixes.
IPV6_UNICAST_PRIVATE_LPM_FORWARD	This resource is consumed for both default and non-default VRF instance IPv6 prefixes.
L3_RIF	This resource is consumed for the L3 interfaces.
L2TPV2_DATA_MESSAGE_TT	This resource is consumed when the L2TP subscribers are created in hardware.
MPLS_FWD	This resource is consumed for MPLS entries for which forwarding actions are involved.
MPLS_TERMINATION_SINGLE_LABEL_DB	This resource is consumed for MPLS entries for which label termination is required.
MULTICAST_MCDB	This resource is consumed for multicast groups created in hardware.
PPPOE_O_ETH_TUNNEL_FULL_SA	This resource is consumed for PPPoE subscribers in hardware.

Example:

```
supervisor@rtbrick.net: cfg> show hardware resource monitor
  Resource Type                                          Consumed Estimated
  ECMP_GROUP                                                    0     40960
  EEDB_ARP                                                     27    114688
  EEDB_L2TP                                                     0    114688
  EEDB_MPLS_TUNNEL                                             11    114688
  EEDB_PPPOE                                                    0    114688
  EEDB_PWE                                                      0    114688
  IN_AC_C_C_VLAN_DB                                             0     60292
```

```
IN_AC_C_VLAN_DB                                    15     60292
IN_AC_S_C_VLAN_DB                                   0     60292
IN_AC_S_VLAN_DB                                     0     60292
IN_AC_UNTAGGED_DB                                   1     60292
IN_LIF_FORMAT_PWE                                   0    131072
IPV4_MULTICAST_PRIVATE_LPM_FORWARD                  0    284160
IPV4_UNICAST_PRIVATE_LPM_FORWARD                    9    568320
IPV4_UNICAST_PRIVATE_LPM_FORWARD_2                  0    284160
IPV6_UNICAST_PRIVATE_LPM_FORWARD                    9    284160
IPV6_UNICAST_PRIVATE_LPM_FORWARD_2                  0    142080
KBP_IPV4_UNICAST_PRIVATE_LPM_FORWARD                0         0
KBP_IPV6_UNICAST_PRIVATE_LPM_FORWARD                0         0
KBP_NAT_EXTERNAL_TO_INTERNAL                        0         0
KBP_NAT_EXTERNAL_TO_INTERNAL_STATS                  0         0
KBP_NAT_INTERNAL_TO_EXTERNAL                        0         0
KBP_NAT_INTERNAL_TO_EXTERNAL_STATS                  0         0
L2TPV2_DATA_MESSAGE_TT                              0     61275
L3V4_EXTERNAL                                       8      1024
L3V6_EXTERNAL                                       7      1024
L3_RIF                                             22     40959
MFV4_EXTERNAL                                       0      2048
MFV6_EXTERNAL                                       0      1024
MPLS_FWD                                            6   1017111
MPLS_TERMINATION_SINGLE_LABEL_DB                    8     61275
MULTICAST_MCDB                                      2    262142
POLICER_EXTERNAL                                    0      4096
PPPOE_O_ETH_TUNNEL_FULL_SA                          0     27361
QOS_CL_ELEMENTS                                     0     30000
QOS_FQ_ELEMENTS                                     0     30000
QOS_HR_ELEMENTS                                   168     30000
QOS_MC_QUEUE_BUNDLES                                1     32000
QOS_SCH_SHARED_SHAPER_DUAL                          0     30000
QOS_SCH_SHARED_SHAPER_OCTA                          0     30000
QOS_SCH_SHARED_SHAPER_QUAD                          0     30000
QOS_UC_QUEUE_BUNDLES                              136     32000
QOS_VOQ_CONNECTOR_BUNDLES                          52     32000
```

QAX Resource Monitoring

QAX platform resource-specific usage metrics are stored in the BDS table: local.bcm.resource.monitor. Resource usage information enables you to understand the scale of services that the device performs and how it optimally leverages the resource usage.

The following table provides the list of supported resource types for monitoring in QAX platforms.

Resource Type	Description
EEDB_ARP	EEDB is an Egress Encapsulation Data Base. This resource is consumed when ARP (Address Resolution Protocol) entries.

Resource Type	Description
ECMP ID	It represents an index in the table that maintains the paths for a particular ECMP route.
Egress Failover ID	It identifies failover paths for traffic leaving the device.
FEC Failover ID	This is used to manage failover paths for FECs.
FECs for Global Use	It represents the number of FECs that are available for general use across the device.
Field Direct Extraction Entry ID	It represents the entries in the FDE table, which are used for direct extraction of fields.
Field Entry ID	It identifies a specific entry used for field-based operations.
Ingress Failover ID	It identifies backup paths for traffic entering the device.
Local Common InLif	It represents the number of common InLifs (Ingress Logical Interface) allocated for incoming traffic.
Local OutLif	It represents the number of logical interfaces allocated for outgoing traffic.
Local Wide InLif	Wide InLifs are used for additional metadata or special handling is required for incoming traffic. It represents the number of wide InLifs allocated for such purposes.
Number of Meters in Processor A	Meters are used for rate limiting or policing traffic, ensuring that traffic adheres to predefined bandwidth limits. This represents the number of meters available and used in processor A.
Profiles for PON Use	Profiles related to Passive Optical Networks are used in the management and configuration of PON interfaces. The number of profiles allocated for PON operations.
QOS EGRESS DSCP/EXP MARKING PROFILE IDs	These IDs represent the QoS marking profiles used to mark outgoing traffic based on DSCP or EXP bits, ensuring the prioritization of outgoing traffic.

Resource Type	Description
QOS EGRESS L2 I TAG PROFILE IDs	These IDs are used for profiles that manage Layer 2 (L2) tagging in egress traffic. The number of available profiles for L2 I Tagging.
QOS EGRESS MPLS PHP QOS IDs	The IDs identify QoS profiles used for MPLS PHP (Penultimate Hop Popping) operations.
QOS EGRESS REMARK QOS IDs	This is used to re-mark packets with a new QoS value as they exit the device. IDs represent the QoS profiles that apply new markings to egress traffic.
QOS INGRESS COS OPCODE IDs	COS (Class of Service) opcodes are used to classify incoming traffic based on criteria such as type of service. The IDs represent different COS opcode profiles for classifying ingress traffic.
QOS INGRESS LABEL MAP ID	Maps are used to associate incoming packets with certain labels for QoS processing. The number of available Label Maps for ingress traffic.
QOS INGRESS LIF/COS IDs	This ID is used for associating incoming traffic with specific LIF (Logical Interface) and COS profiles for handling. The number of IDs available for mapping ingress traffic to LIF/COS profiles.
QOS INGRESS PCP PROFILE IDs	Priority Code Point (PCP) profiles are used to prioritize packets at the ingress based on their PCP value. The IDs represent available PCP profiles for prioritizing ingress traffic.
SW Handles of Policer	It represents the number of software handles available for configuring policers.
Trill Virtual Nickname	It represents the number of virtual nicknames allocated for TRILL protocol operations for creating loop-free multi-path Ethernet network.
VLAN Translation Egress Usage	The number of entries used for VLAN translation operations on out-going traffic.
VLAN Translation Ingress Usage	The number of entries used for VLAN translation on incoming traffic.
VSIs for MSTP	The number of VSIs (Virtual Switch Instances) allocated for MSTP operations.

Resource Type	Description
VSIs for TB VLANS	The number of VSIs allocated for handling TB VLANs.

Supported Platforms

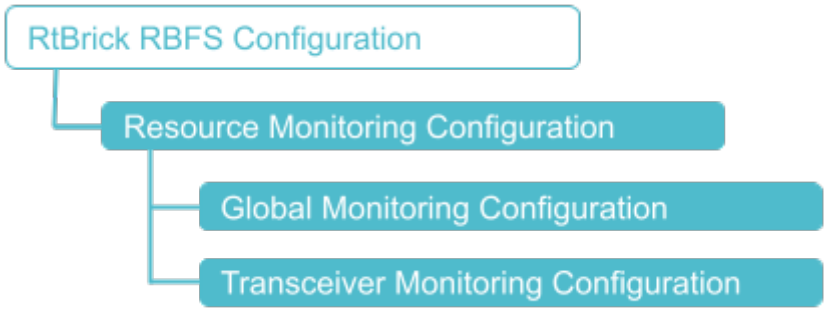
Not all features are necessarily supported on each hardware platform. Refer to the *Platform Guide* for the features and the sub-features that are or are not supported by each platform.

10.2.2. Resource Monitoring Configuration

Configuration Hierarchy

The diagram illustrates the resource monitoring configuration hierarchy.

Optic Configuration Hierarchy



Configuration Syntax and Commands

The following sections describe the configuration syntax and commands.

Global Monitoring Configuration

This command sets the poll-interval for the resource monitoring functionality to discover transceivers.

Syntax:

```
set resmon monitoring <poll-interval>
```

Attribute	Description
poll_interval <poll-interval>	Specifies the interval (in seconds) at which transceiver should be polled. The interval can range from 3 to 10000 seconds. The default interval is 10 seconds.

API To access the RESTCONF API that corresponds to this CLI, click here.

Transceiver Configuration

You can use this command to disable or enable (By, default enabled) tx laser or high-power class of an transceiver module on a specific interface.

Syntax:

set resmon optics <interface> ...

Attribute	Description
interface <interface-name>	Name of the interface
high-power-class [disable / enable]	Enable or disable high power class for transceiver module. Enabled, by default.
tx [disable / enable]	Enable or disable lasers for transceiver module. Enabled, by default.

API To access the RESTCONF API that corresponds to this CLI, click here.

QoS Resource Monitoring

RBFS provides resource monitoring support for Quality of Service (QoS) components. It provides visibility into current usage and maximum capacity for various QoS components.

Resource monitoring is enabled for the following QoS components:

- QOS_CL_ELEMENTS
- QOS_FQ_ELEMENTS
- QOS_HR_ELEMENTS

- QOS_MC_QUEUE_BUNDLES
- QOS_SCH_SHARED_SHAPER_DUAL
- QOS_SCH_SHARED_SHAPER_OCTA
- QOS_SCH_SHARED_SHAPER_QUAD
- QOS_UC_QUEUE_BUNDLES
- QOS_VOQ_CONNECTOR_BUNDLES

Example:

```
supervisor@rtbrick>LEAF01: cfg> show hardware resource monitor
<...>
  QOS_CL_ELEMENTS                                          0     30000
  QOS_FQ_ELEMENTS                                          0     30000
  QOS_HR_ELEMENTS                                        170     30000
  QOS_MC_QUEUE_BUNDLES                                     1     32000
  QOS_SCH_SHARED_SHAPER_DUAL                           12004     30000
  QOS_SCH_SHARED_SHAPER_OCTA                               0     30000
  QOS_SCH_SHARED_SHAPER_QUAD                               0     30000
  QOS_UC_QUEUE_BUNDLES                                 12106     32000
  QOS_VOQ_CONNECTOR_BUNDLES                            12021     32000
```

API Endpoint to Perform Power-Cycle Operation

You can use the API endpoint to perform the power-cycle operation. The following is the CTRLD API endpoint to perform the power-cycle operation.

POST /api/v1/ctrld/system/_powercycle

As shown in the example below, you can use CURL to invoke the power cycle function.

```
curl -i -H "Content-Type: application/json" -X POST http://<ip of
router>:19091/api/v1/ctrld/system/_powercycle
```



In the above URL, 19091 is a port number. This is the only supported port for this.

10.2.3. Resmon Operational Commands

Resmon Show Commands

The Resmon show commands provide detailed information about the resources and their usage.

CPU Information

This command displays the CPU detail and CPU information.

Syntax:

show cpu <option>

Option	Description
summary	Displays the CPU information.
usage	Displays the CPU usage information

Example 1: CPU summary

```
supervisor@rtbrick: op> show cpu summary
CPU_0
  Vendor               : GenuineIntel
  Model                : Intel(R) Xeon(R) CPU D-1518 @ 2.20GHz
  Architecture         : x86_64
  Serial No            : 12 34 56 78 AB CD EF GH
  Clock(MHz)           : 1996.620
  BogoMIPS             : 4400.00
  Physical cores       : 4
  Logical cores        : 8
  Endian               : True
  Cache alignment      : 64 Bytes
  L1 data cache        : 32768 Bytes
  L1 instruction cache : 32768 Bytes
  L2 unified cache     : 262144 Bytes
  L3 unified cache     : 6291456 Bytes
  L4 unified cache     : 0 Bytes
supervisor@rtbrick: op>
```

Example 2: CPU usage information.

```
supervisor@rtbrick: op> show cpu usage
Name         Total       User     System       Nice   I/O Wait       Idle        IRQ   Soft IRQ
cpu            31%        23%         8%         0%         0%        68%         0%         0%
cpu0           11%         4%         5%         0%         0%        88%         0%         2%
cpu1          100%        63%        36%         0%         0%         0%         0%         0%
cpu2           54%        51%         2%         0%         0%        45%         0%         0%
cpu3           57%        55%         2%         0%         0%        42%         0%         0%
```

```
cpu4            6%          1%          5%          0%          0%          93%         0%          0%
cpu5            4%          2%          2%          0%          0%          95%         0%          0%
cpu6            8%          3%          4%          0%          0%          91%         0%          0%
cpu7            6%          1%          5%          0%          0%          94%         0%          0%
supervisor@rtbrick: op>
```

Memory Details

This command displays the memory details and usage information.

Syntax:

show memory <option>

Option	Description
summary	Displays the system memory information.
usage	Displays the memory usage information.

Example 1: System memory information

```
supervisor@rtbrick: op> show memory summary
System Memory
  Maximum capacity                : 128 GB
  Error correction type           : Multi-bit ECC
  Number of memory slots available : 4
  Number of memory slots occupied  : 2
Bank              Size        Location          Type      Speed       Configured Speed   Vendor      Serial
No      Part No
NODE 1            8192 MB     DIMM_A1           DDR4      2133 MT/s   2133 MT/s          Undefined   00000001
TS1GSH72V1H
NODE 1            8192 MB     DIMM_B1           DDR4      2133 MT/s   2133 MT/s          Undefined   00000002
TS1GSH72V1H
```

Example 2: System memory usage information.

```
supervisor@rtbrick: op> show memory usage
Name      Total             Used              Free          Shared        Buffers       Cached
RAM       16.69 GB          4.54 GB           10.08 GB      578.17 MB     103.12 MB     2.06 GB
SWAP      0 bytes           0 bytes           0 bytes       n/a           n/a           n/a
```

Process Details

This command displays the process usage information.

Syntax:

show process usage <option>

Option	Description
process-id <pid>	Displays the process usage for the specified process identifier.
process-name <process-name>	Displays the process usage for the specified process.
summary	Displays the process usage summary information.

Example 1: Process usage summary information.

```
supervisor@rtbrick: op> show process usage summary
Name             PID         VIRT             Resident Memory       Sharable Memory     CPU Percentage
Memory Percentage   CPU Affinity
bgp.appd.1       4456        384.67 MB        122.69 MB             29.32 MB            0.81
0.74                0-7
bgp.iod.1        4469        694.63 MB        148.39 MB             30.22 MB            2.01
0.89                0-7
confd            213         1.24 GB          769.9 MB              31.89 MB            0.81
4.61                0-7
etcd             110         600.9 MB         196.4 MB              29.26 MB            1.21
1.18                0-7
fibd             288         13.68 GB         1.74 GB               210.79 MB           161.17
10.45               1
ifmd             147         496.74 MB        154.25 MB             29.99 MB            1.01
0.92                0-7
igmp.appd.1      4482        356.38 MB        100.29 MB             29.27 MB            1.01             0.6
0-7
igmp.iod.1       4495        540.14 MB        132.68 MB             29.41 MB            2.01             0.8
0-7
ipoed.1          175         503.51 MB        112.9 MB              29.3 MB             2.01
0.68                0-7
l2tpd.1          4508        475.71 MB        103.45 MB             29.26 MB            2.01
0.62                0-7
lldpd            128         368.32 MB        106.75 MB             29.29 MB            2.21
0.64                0-7
mribd            158         381.8 MB         115.57 MB             29.38 MB            1.01
0.69                0-7
```

Example 2: Process usage for the specified process.

```
supervisor@rtbrick: op> show process usage process-name fibd
Process Name: fibd
  PID                          : 288
  REST port                    : 5522
  Debug port                   : 5521
  Allowed CPU list             : 1
  CPU usage at user space      : 25964
  CPU usage at kernel space    : 12633
  CPU usage percentage         : 152.815678
  Memory usage percentage      : 10.452729
  Peak virtual memory usage    : 13355692
  Current virtual memory usage : 13.68 GB
```

```
  <...>
```

Example 3: Process usage for the specified process ID.

```
supervisor@rtbrick: op> show process usage process-id 4456
Process Name: bgp.appd.1
  PID                           : 4456
  REST port                     : 4102
  Debug port                    : 4101
  Allowed CPU list              : 0-7
  CPU usage at user space       : 20103
  CPU usage at kernel space     : 18011
  CPU usage percentage          : 1.011122
  Memory usage percentage       : 0.735218
  Peak virtual memory usage     : 375652
  Current virtual memory usage : 384.67 MB
  Locked virtual memory         : n/a
  RSS virtual memory            : 122.69 MB
  <...>
```

Sensor Details

This command displays the fan, power-supply, and temperature information.

Syntax:

show sensor <option>

Option	Description
fan	Displays information about the sensor fan.
power-supply	Displays the sensor power supply information.
temperature	Displays the sensor temperature information.

Sensor Information

The show sensor command displays information about fan parameters, power-supply unit parameters, thermal sensors present on the system.

Syntax:

show sensor [**power-supply** | **fan** | **temperature**]

Option	Description
fan	Displays information about fan parameters.
power-supply	Displays information about power-supply unit parameters.
temperature	Displays information about thermal sensors present on the system.

Example: Summary information for sensor fan.

```
supervisor@rtbrick.net: cfg> show sensor fan
Name: CHASSIS FAN 1, Location: Fan Board
Status: -|PRESENT|-|-|F2B|-, BMC status: ok
  Attribute       Value  Low Warn  Upper Warn  Low Crit  Upper Crit  Low Shut  Upper Shut
  Speed(RPM)     7700.0      6000         n/a      3200         n/a      2400         n/a
Name: CHASSIS FAN 2, Location: Fan Board
Status: -|PRESENT|-|-|F2B|-, BMC status: ok
  Attribute       Value  Low Warn  Upper Warn  Low Crit  Upper Crit  Low Shut  Upper Shut
  Speed(RPM)     7700.0      6000         n/a      3200         n/a      2400         n/a
Name: CHASSIS FAN 3, Location: Fan Board
Status: -|PRESENT|-|-|F2B|-, BMC status: ok
  Attribute       Value  Low Warn  Upper Warn  Low Crit  Upper Crit  Low Shut  Upper Shut
  Speed(RPM)     7700.0      6000         n/a      3200         n/a      2400         n/a
Name: PSU 0 FAN, Location: PSU 0
Status: -|PRESENT|-|-|F2B|-, BMC status: ok
  Attribute       Value  Low Warn  Upper Warn  Low Crit  Upper Crit  Low Shut  Upper Shut
  Speed(RPM)    11520.0       n/a         n/a      3600         n/a      3330         n/a
Name: PSU 1 FAN, Location: PSU 1
Status: -|PRESENT|-|-|F2B|-, BMC status: Lower Non-Recoverable
  Attribute       Value  Low Warn  Upper Warn  Low Crit  Upper Crit  Low Shut  Upper Shut
  Speed(RPM)        0.0       n/a         n/a      3600         n/a      3330         n/a
```

Example: Sensor temperature

```
supervisor@rtbrick.net: cfg> show sensor temperature
Name                   Location    Temp(°C)  Low Warn  Upper Warn  Low Crit  Upper Crit  Low Shut  Upper Shut
Status
Ambient Thermal        Main Board      38.0       n/a         n/a       -42          80       -45          84
-|PRESENT|-|-|-|-
CPU Board              CPU             42.0       n/a          45       n/a          55       n/a          60
-|PRESENT|-|-|-|-
CPU Package            CPU             59.0       n/a          45       n/a          55       n/a          60
-|PRESENT|-|-|-|-
CPU Thermal 1          CPU             59.0       n/a          45       n/a          55       n/a          60
-|PRESENT|-|-|-|-
CPU Thermal 2          CPU             59.0       n/a          45       n/a          55       n/a          60
-|PRESENT|-|-|-|-
CPU Thermal 3          CPU             58.0       n/a          45       n/a          55       n/a          60
-|PRESENT|-|-|-|-
CPU Thermal 4          CPU             58.0       n/a          45       n/a          55       n/a          60
-|PRESENT|-|-|-|-
HWM_Temp_BMC           BMC Chipset     46.0       n/a         n/a       -42          85       -45          89
-|PRESENT|-|-|-|-
HWM_Temp_CPU           CPU             49.0       n/a         n/a       -42          90       -45          95
-|PRESENT|-|-|-|-
HWM_Temp_MAC           Main Board      48.0       n/a         n/a       -42          90       -45          95
-|PRESENT|-|-|-|-
PSU 0 - Thermal Sensor PSU 0           40.0       n/a         n/a       n/a          90       n/a          95
-|PRESENT|-|-|-|-
```

```
PSU 1 - Thermal Sensor PSU 1          36.0       n/a         n/a       n/a          90       n/a          95
-|PRESENT|-|-|-|-
Temp_100GCage          Main Board     27.0       n/a         n/a       n/a          82       n/a          85
-|PRESENT|-|-|-|-
Temp_BMC               Main Board     44.0       n/a         n/a       n/a          85       n/a          89
-|PRESENT|-|-|-|-
Temp_CPU               Main Board     59.0       n/a         n/a       n/a          97       n/a         102
-|PRESENT|-|-|-|-
Temp_DDR4              Main Board     42.0       n/a         n/a       n/a          90       n/a          92
-|PRESENT|-|-|-|-
Temp_FANCARD1          Main Board     37.0       n/a         n/a       n/a          85       n/a          89
-|PRESENT|-|-|-|-
Temp_FANCARD2          Main Board     34.0       n/a         n/a       n/a          85       n/a          89
-|PRESENT|-|-|-|-
Temp_Heater            Main Board     51.0       n/a         n/a       -42          75       -45          78
-|PRESENT|-|-|-|-
Temp_MAC               Main Board     53.0       n/a         n/a       n/a         101       n/a         106
-|PRESENT|-|-|-|-
Temp_PHY1              Main Board     44.0       n/a         n/a       -42          90       -45          95
-|PRESENT|-|-|-|-
```

Example: Power-supply unit parameters details

```
supervisor@rtbrick.net: cfg> show sensor power-supply
Name: PSU 0, Manufacturer: FSPGROUP, Product name: YSEJ0200BM, Part number: YSEJ0200BM-2R01G10, Serial
number: F2010AT90250V080080
Status: -|PRESENT|-|-|-|-, BMC status: OK
  Attribute       Value  Low Warn  Upper Warn  Low Crit  Upper Crit  Low Shut  Upper Shut
  IIn(Amps)        0.36       n/a         n/a       n/a         n/a       n/a         n/a
  IOut(Amps)       4.92       n/a         n/a       n/a         n/a       n/a         n/a
  VIn(Volts)      224.0       n/a         n/a       n/a         n/a       n/a         n/a
  VOut(Volts)     11.82       n/a         n/a       n/a         n/a       n/a         n/a
  PIn(Watts)      80.64       n/a         n/a       n/a         n/a       n/a         n/a
  POut(Watts)     58.15       n/a         n/a       n/a         n/a       n/a         n/a
Name: PSU 1, Manufacturer: FSPGROUP, Product name: YSEJ0200BM, Part number: YSEJ0200BM-2R01G10, Serial
number: F2010AT90250V080072
Status: -|PRESENT|FAILED|-|-|-, BMC status: POWER_FAILED
  Attribute       Value  Low Warn  Upper Warn  Low Crit  Upper Crit  Low Shut  Upper Shut
  IIn(Amps)         0.0       n/a         n/a       n/a         n/a       n/a         n/a
  IOut(Amps)        0.0       n/a         n/a       n/a         n/a       n/a         n/a
  VIn(Volts)        0.0       n/a         n/a       n/a         n/a       n/a         n/a
  VOut(Volts)       0.0       n/a         n/a       n/a         n/a       n/a         n/a
  PIn(Watts)        0.0       n/a         n/a       n/a         n/a       n/a         n/a
  POut(Watts)       0.0       n/a         n/a       n/a         n/a       n/a         n/a
```

Example: Sensor temperature.

```
supervisor@rtbrick.net: op> show sensor temperature
Name                      Temperature         Status
CPU Package Thermal           36.0 °C         -|PRESENT|-|-|-
PSU 0 THERMAL 1               32.0 °C         -|PRESENT|-|-|-
PSU 1 THERMAL 1               33.0 °C         -|PRESENT|-|-|-
TEMP_CPU_PECI                 38.0 °C         -|PRESENT|-|-|-
TEMP_ENV0                     30.0 °C         -|PRESENT|-|-|-
TEMP_ENV1                     33.0 °C         -|PRESENT|-|-|-
TEMP_ENV_CPU                  35.0 °C         -|PRESENT|-|-|-
TEMP_ENV_MAC0                 32.0 °C         -|PRESENT|-|-|-
TEMP_MAC0                     60.0 °C         -|PRESENT|-|-|-
```

System LED Details

Display information about system LED parameters.

Syntax:

show system-led

```
supervisor@rtbrick.net: op> show system-led
Name                       Colour  Blinking  Status
CHASSIS LED 1 (SYNC LED)  green   disabled  -|PRESENT|-|-|-
CHASSIS LED 2 (SYS LED)   green   disabled  -|PRESENT|-|ON|-
CHASSIS LED 3 (FAN LED)   green   disabled  -|PRESENT|-|ON|-
CHASSIS LED 4 (PSU0 LED)  green   disabled  -|PRESENT|-|ON|-
CHASSIS LED 5 (PSU1 LED)  yellow  enabled   -|PRESENT|-|ON|-
```

Transceiver Details

These show commands display information about transceivers.

Syntax:

show transceiver [<interface-name> | detail]

Option	Description
-	Without any option, the command displays the information for all transceivers.
<interface-name>	Displays detailed information for the transceiver.
detail	Displays the detailed view for a specified transceiver or all transceivers.

Example (show transceiver) command output> It displays all transceiver information

```
supervisor@rtbrick.net: op> show transceiver
Interface      Module Type  Transceiver Name    Connector Type          PC         Vendor        Part Number
Serial Number     Material Number
ifp-0/0/1      QSFP28       100G-CWDM4          LC (Lucent Connector)   4(3.5W)    FS            QSFP28-IR4-
100G    F2030883005       CMUIAMACAB10-3146-02
ifp-0/0/2      QSFP28       100GBASE-CR4        No separable connector  n/a        FS            Q28-PC02
G2006417081-2     n/a
ifp-0/0/3      QSFP28       100G-CWDM4          LC (Lucent Connector)   4(3.5W)    FS            QSFP28-IR4-
```

```
100G    F2030882983       CMUIAMACAB10-3146-02
ifp-0/1/4      SFP          25GBASE-CR          Copper Pigtail          n/a        FS            S28-PC01
G2110077546-1     n/a
ifp-0/1/5      SFP          1GBASE-T            n/a                     n/a        FS            SFP-GB-GE-T
F1940056064       n/a
ifp-0/1/6      SFP          1GBASE-T            n/a                     n/a        FS            SFP-GB-GE-T
G1809118354       n/a
ifp-0/1/7      SFP          10GBASE-CR Passive  Copper Pigtail          n/a        FS            SFPP-PC015
S2108004622-2     n/a
ifp-0/1/8      SFP          10GBASE-CR Passive  Copper Pigtail          n/a        FS            SFPP-PC02
F2011245178-1     n/a
ifp-0/1/9      SFP          10GBASE-CR Passive  Copper Pigtail          n/a        FS            SFPP-PC02
F2011245179-1     n/a
ifp-0/1/10     SFP          10GBASE-CR Passive  Copper Pigtail          n/a        FS            SFPP-PC02
F2011245154-1     n/a
ifp-0/1/11     SFP          10GBASE-CR Passive  Copper Pigtail          n/a        FS            SFPP-PC01
F2032547869-2     n/a
ifp-0/1/12     SFP          10GBASE-CR Passive  Copper Pigtail          n/a        FS            SFPP-PC01
F2032547859-2     n/a
ifp-0/1/13     SFP          10GBASE-CR Passive  Copper Pigtail          n/a        FS            SFPP-PC01
F2032547887-1     n/a
ifp-0/1/14     SFP          10GBASE-LR          LC (Lucent Connector)   1(1.5W)    FS            SFP-10GLR-
31       F1930111179       n/a
ifp-0/1/15     SFP          10GBASE-CR Passive  Copper Pigtail          n/a        FS            SFPP-PC01
F2032547865-2     n/a
ifp-0/1/16     SFP          25GBASE-CR          Copper Pigtail          n/a        FS            S28-PC015
S2108224439-1     n/a
ifp-0/1/17     SFP          25GBASE-CR          Copper Pigtail          n/a        FS            S28-PC015
S2108224426-1     n/a
<...>
```

Example output for a specified transceiver.

```
supervisor@rtbrick.net: op> show transceiver ifp-0/0/0
ifp-0/0/0
  Transceiver name: ZR400-OFEC-16QAM, Vendor name: FLEXOPTIX, Module type: QSFP-DD, Serial number: F824HMC
  Part number: D.CO164HG.16.yTM, Material number: n/a
  Power class: 8(14.0W), Power class mode: HIGH
  Connector type: LC (Lucent Connector), Link length support: 600km(smf), Wavelength: 1552.50 nm
  Capabilities: [Tx-Disable, Diagnostic Monitoring, Supply Voltage Monitoring, Temperature Monitoring,
Transmitter Power Measurement]
  Manufactured date: Mon Jul 15 00:00:00 GMT +0000 2024
  Transceiver Diagnostic Monitoring
    Attribute             Value           High Alarm     High Warn      Low Alarm     Low Warn
    Temperature           46.7773 C       False          False          False         False
    Voltage                3.2726 V       False          False          False         False
  Transceiver Lane Diagnostic Monitoring
    Lane: 0
      Attribute           Value           High Alarm     High Warn      Low Alarm     Low Warn
      RxPower         -17.471470 dBm      False          False          False         False
      TxPower          -0.091729 dBm      False          False          False         False
      TxBiascurrent   213.503998 mA       False          False          False         False
    Lane: 1
      Attribute           Value           High Alarm     High Warn      Low Alarm     Low Warn
      RxPower         -30.000000 dBm      False          False          False         False
      TxPower         -30.000000 dBm      False          False          False         False
      TxBiascurrent     0.000000 mA       False          False          False         False
    Lane: 2
      Attribute           Value           High Alarm     High Warn      Low Alarm     Low Warn
      RxPower         -30.000000 dBm      False          False          False         False
      TxPower         -30.000000 dBm      False          False          False         False
      TxBiascurrent     0.000000 mA       False          False          False         False
    Lane: 3
      Attribute           Value           High Alarm     High Warn      Low Alarm     Low Warn
      RxPower         -30.000000 dBm      False          False          False         False
      TxPower         -30.000000 dBm      False          False          False         False
      TxBiascurrent     0.000000 mA       False          False          False         False
    Lane: 4
      Attribute           Value           High Alarm     High Warn      Low Alarm     Low Warn
      RxPower         -30.000000 dBm      False          False          False         False
      TxPower         -30.000000 dBm      False          False          False         False
      TxBiascurrent     0.000000 mA       False          False          False         False
    Lane: 5
```

```
      Attribute           Value           High Alarm     High Warn      Low Alarm     Low Warn
      RxPower         -30.000000 dBm      False          False          False         False
      TxPower         -30.000000 dBm      False          False          False         False
      TxBiascurrent     0.000000 mA       False          False          False         False
    Lane: 6
      Attribute           Value           High Alarm     High Warn      Low Alarm     Low Warn
      RxPower         -30.000000 dBm      False          False          False         False
      TxPower         -30.000000 dBm      False          False          False         False
      TxBiascurrent     0.000000 mA       False          False          False         False
    Lane: 7
      Attribute           Value           High Alarm     High Warn      Low Alarm     Low Warn
      RxPower         -30.000000 dBm      False          False          False         False
      TxPower         -30.000000 dBm      False          False          False         False
      TxBiascurrent     0.000000 mA       False          False          False         False
```

The following is a show command output displays an indicator for the specified transceiver 'ifp-0/1/10'.

```
supervisor@rtbrick.net: cfg> show transceiver ifp-0/1/10
ifp-0/1/10
  Transceiver name: n/a, Vendor name: n/a, Module type: Unknown(Transceiver-EEPROM
corruption/read-failure), Serial number: n/a
  Part number: n/a, Material number: n/a
  Power class: n/a
  Connector type: n/a, Link length support: n/a  Manufactured date: n/a
```



An error indicator in the output flags an error message for broken or faulty transceivers or when the transceiver EEPROM is corrupted or cannot be read. It allows for quick fault identification without the need for additional diagnostic steps.

Example for detailed view for the specified transceiver interface.

```
supervisor@rtbrick.net: op> show transceiver ifp-0/0/1 detail
Interface name: ifp-0/0/1
  Transceiver name: 100G-CWDM4, Vendor name: FS, Module type: QSFP28
  Serial number: F2030883005, Part number: QSFP28-IR4-100G, Material number: CMUIAMACAB10-3146-02
  Power class: 4(3.5W), Power class mode: HIGH
  Connector type: LC (Lucent Connector)
  Link length support: 2km(smf), Wavelength: 1310.00 nm
  Capabilities: [Tx-Disable, Diagnostic Monitoring, Extended Rate Select, Transmitter Power Measurement,
Receiver Power Measurement(AVG)]
  Manufactured date: Mon Feb 10 00:00:00 GMT +0000 2020
  Temperature parameters:
    Temperature: 27.14 °C
    Temperature low warning: False, Threshold: -5.00 °C
    Temperature low alarm: False, Threshold: -10.00 °C
    Temperature high warning: False, Threshold: 75.00 °C
    Temperature high alarm: False, Threshold: 80.00 °C
  Voltage parameters:
    Voltage: 3.23 V
    Voltage low warning: False, Threshold: 3.05 V
    Voltage low alarm: False, Threshold: 2.97 V
    Voltage high warning: False, Threshold: 3.55 V
    Voltage high alarm: False, Threshold: 3.63 V
  Lane Id: 0
    Interrupt parameters:
      Tx disable: False, Laser Tx loss of signal: False, Laser Tx loss of lock: False
      Laser Rx loss of signal: False, Laser Rx loss of lock: False
    Laser bias current parameters:
      Laser bias current: 28.872 mA
      Laser bias current low warning: False, Threshold: 10.00 mA
```

```
      Laser bias current low alarm: False, Threshold: 5.00 mA
      Laser bias current high warning: False, Threshold: 100.00 mA
      Laser bias current high alarm: False, Threshold: 110.00 mA
    Laser Tx power parameters:
      Laser Tx power: 1.175 mW / 0.699 dBm
      Laser Tx power low warning: False, Threshold: 0.22 mW / -6.50 dBm
      Laser Tx power low alarm: False, Threshold: 0.18 mW / -7.50 dBm
      Laser Tx power high warning: False, Threshold: 2.82 mW / 4.50 dBm
      Laser Tx power high alarm: False, Threshold: 3.55 mW / 5.50 dBm
    Laser Rx power parameters:
      Laser Rx power: 0.953 mW / -0.21 dBm
      Laser Rx power low warning: False, Threshold: 0.06 mW / -12.00 dBm
      Laser Rx power low alarm: False, Threshold: 0.05 mW / -13.00 dBm
      Laser Rx power high warning: False, Threshold: 2.82 mW / 4.50 dBm
      Laser Rx power high alarm: False, Threshold: 3.55 mW / 5.50 dBm
  Lane Id: 1
    Interrupt parameters:
      Tx disable: False, Laser Tx loss of signal: False, Laser Tx loss of lock: False
      Laser Rx loss of signal: False, Laser Rx loss of lock: False
    Laser bias current parameters:
      Laser bias current: 29.296 mA
      Laser bias current low warning: False, Threshold: 10.00 mA
      Laser bias current low alarm: False, Threshold: 5.00 mA
      Laser bias current high warning: False, Threshold: 100.00 mA
      Laser bias current high alarm: False, Threshold: 110.00 mA
    Laser Tx power parameters:
      Laser Tx power: 1.43 mW / 1.552 dBm
      Laser Tx power low warning: False, Threshold: 0.22 mW / -6.50 dBm
      Laser Tx power low alarm: False, Threshold: 0.18 mW / -7.50 dBm
      Laser Tx power high warning: False, Threshold: 2.82 mW / 4.50 dBm
      Laser Tx power high alarm: False, Threshold: 3.55 mW / 5.50 dBm
    Laser Rx power parameters:
      Laser Rx power: 1.066 mW / 0.278 dBm
      Laser Rx power low warning: False, Threshold: 0.06 mW / -12.00 dBm
      Laser Rx power low alarm: False, Threshold: 0.05 mW / -13.00 dBm
      Laser Rx power high warning: False, Threshold: 2.82 mW / 4.50 dBm
      Laser Rx power high alarm: False, Threshold: 3.55 mW / 5.50 dBm
  Lane Id: 2
    Interrupt parameters:
      Tx disable: False, Laser Tx loss of signal: False, Laser Tx loss of lock: False
      Laser Rx loss of signal: False, Laser Rx loss of lock: False
    Laser bias current parameters:
      Laser bias current: 38.664 mA
      Laser bias current low warning: False, Threshold: 10.00 mA
      Laser bias current low alarm: False, Threshold: 5.00 mA
      Laser bias current high warning: False, Threshold: 100.00 mA
      Laser bias current high alarm: False, Threshold: 110.00 mA
    Laser Tx power parameters:
      Laser Tx power: 1.141 mW / 0.573 dBm
      Laser Tx power low warning: False, Threshold: 0.22 mW / -6.50 dBm
      Laser Tx power low alarm: False, Threshold: 0.18 mW / -7.50 dBm
      Laser Tx power high warning: False, Threshold: 2.82 mW / 4.50 dBm
      Laser Tx power high alarm: False, Threshold: 3.55 mW / 5.50 dBm
    Laser Rx power parameters:
      Laser Rx power: 1.056 mW / 0.235 dBm
      Laser Rx power low warning: False, Threshold: 0.06 mW / -12.00 dBm
      Laser Rx power low alarm: False, Threshold: 0.05 mW / -13.00 dBm
      Laser Rx power high warning: False, Threshold: 2.82 mW / 4.50 dBm
      Laser Rx power high alarm: False, Threshold: 3.55 mW / 5.50 dBm
```

Example for detailed view for all transceiver interfaces.

```
supervisor@rtbrick.net: cfg> show transceiver detail
Interface name: ifp-0/1/0
  Transceiver name: 10GBASE-CR Passive
  Vendor name: FS
  Module type: SFP
  Serial number: F2011247641-2
  Part number: SFPP-PC02
  Material number: n/a
  Power class: n/a
  Connector type: Copper Pigtail
  Cable technology: Passive Cable
```

```
  Link length support: 2m(om4)
  Capabilities: [Tx-Disable, Receiver Power Measurement(OMA)]
  Manufactured date: Tue Mar 01 00:00:00 GMT +0000 2022
  Lane Id: 0
    Interrupt parameters:
      Tx disable: False
      Laser Rx loss of signal: False
Interface name: ifp-0/1/1
  Transceiver name: 10GBASE-CR Passive
  Vendor name: FS
  Module type: SFP
  Serial number: F2011247625-2
  Part number: SFPP-PC02
  Material number: n/a
  Power class: n/a
  Connector type: Copper Pigtail
  Cable technology: Passive Cable
  Link length support: 2m(om4)
  Capabilities: [Tx-Disable, Receiver Power Measurement(OMA)]
  Manufactured date: Tue Mar 01 00:00:00 GMT +0000 2022
  Lane Id: 0
    Interrupt parameters:
      Tx disable: False
      Laser Rx loss of signal: False
Interface name: ifp-0/1/2
  Transceiver name: 10GBASE-CR Passive
  Vendor name: FS
  Module type: SFP
  Serial number: F2011247648-1
  Part number: SFPP-PC02
  Material number: n/a
  Power class: n/a
  Connector type: Copper Pigtail
  Cable technology: Passive Cable
  Link length support: 2m(om4)
  Capabilities: [Tx-Disable, Receiver Power Measurement(OMA)]
  Manufactured date: Tue Mar 01 00:00:00 GMT +0000 2022
  Lane Id: 0
    Interrupt parameters:
      Tx disable: False
      Laser Rx loss of signal: False
Interface name: ifp-0/1/3
  Transceiver name: 10GBASE-CR Passive
  Vendor name: FS
  Module type: SFP
  Serial number: F2011247650-1
  Part number: SFPP-PC02
  Material number: n/a
  Power class: n/a
  Connector type: Copper Pigtail
  Cable technology: Passive Cable
  Link length support: 2m(om4)
  Capabilities: [Tx-Disable, Receiver Power Measurement(OMA)]
  Manufactured date: Tue Mar 01 00:00:00 GMT +0000 2022
  Lane Id: 0
    Interrupt parameters:
      Tx disable: False
      Laser Rx loss of signal: False
Interface name: ifp-0/1/8
  Transceiver name: 25GBASE-CR
  Vendor name: FS
  Module type: SFP
  Serial number: S2108224437-2
  Part number: S28-PC015
  Material number: n/a
  Power class: n/a
  Connector type: Copper Pigtail
  Cable technology: Passive Cable
  Link length support: 3m(om4)
  Capabilities: [Receiver Power Measurement(OMA)]
  Manufactured date: Thu Sep 02 00:00:00 GMT +0000 2021
  Lane Id: 0
    Interrupt parameters:
      Tx disable: False
      Laser Rx loss of signal: False
Interface name: ifp-0/1/9
  Transceiver name: 25GBASE-CR
```

```
  Vendor name: FS
  Module type: SFP
  Serial number: S2108224434-1
  Part number: S28-PC015
  Material number: n/a
  Power class: n/a
  Connector type: Copper Pigtail
  Cable technology: Passive Cable
  Link length support: 3m(om4)
  Capabilities: [Receiver Power Measurement(OMA)]
  Manufactured date: Thu Sep 02 00:00:00 GMT +0000 2021
  Lane Id: 0
    Interrupt parameters:
      Tx disable: False
      Laser Rx loss of signal: False
Interface name: ifp-0/1/66
  Transceiver name: 100GBASE-CR4
  Vendor name: FS
  Module type: QSFP28
  Serial number: G2110248571-2
  Part number: Q28-PC005
  Material number: n/a
  Power class: n/a
  Connector type: No separable connector
  Link length support: 1m(om4)
  Capabilities: [Receiver Power Measurement(OMA)]
  Manufactured date: Sat May 08 00:00:00 GMT +0000 2021
  Lane Id: 0
    Interrupt parameters:
      Tx disable: False
      Laser Tx loss of signal: False
      Laser Tx loss of lock: False
      Laser Rx loss of signal: False
      Laser Rx loss of lock: False
  Lane Id: 1
    Interrupt parameters:
      Tx disable: False
      Laser Tx loss of signal: False
      Laser Tx loss of lock: False
      Laser Rx loss of signal: False
      Laser Rx loss of lock: False
  Lane Id: 2
    Interrupt parameters:
      Tx disable: False
      Laser Tx loss of signal: False
      Laser Tx loss of lock: False
      Laser Rx loss of signal: False
      Laser Rx loss of lock: False
  Lane Id: 3
    Interrupt parameters:
      Tx disable: False
      Laser Tx loss of signal: False
      Laser Tx loss of lock: False
      Laser Rx loss of signal: False
      Laser Rx loss of lock: False
Interface name: ifp-0/1/67
  Transceiver name: 100GBASE-CR4
  Vendor name: Fiberstore
  Module type: QSFP28
  Serial number: F1800034273-2
  Part number: Q28-PC01
  Material number: n/a
  Power class: n/a
  Connector type: No separable connector
  Link length support: 1m(om4)
  Capabilities: [Receiver Power Measurement(OMA)]
  Manufactured date: Tue Jan 16 00:00:00 GMT +0000 2018
  Lane Id: 0
    Interrupt parameters:
      Tx disable: False
      Laser Tx loss of signal: False
      Laser Tx loss of lock: False
      Laser Rx loss of signal: False
      Laser Rx loss of lock: False
  Lane Id: 1
    Interrupt parameters:
      Tx disable: False
```

```
      Laser Tx loss of signal: False
      Laser Tx loss of lock: False
      Laser Rx loss of signal: False
      Laser Rx loss of lock: False
  Lane Id: 2
    Interrupt parameters:
      Tx disable: False
      Laser Tx loss of signal: False
      Laser Tx loss of lock: False
      Laser Rx loss of signal: False
      Laser Rx loss of lock: False
  Lane Id: 3
    Interrupt parameters:
      Tx disable: False
      Laser Tx loss of signal: False
      Laser Tx loss of lock: False
      Laser Rx loss of signal: False
      Laser Rx loss of lock: False
Interface name: ifp-0/1/70
  Transceiver name: 100GBASE-LR4
  Vendor name: LambdaGain
  Module type: QSFP28
  Serial number: L02A7K0046
  Part number: LL1S31B0A
  Material number: T-UNIQSF40907039
  Power class: 4(3.5W)
  Power class mode: HIGH
  Connector type: LC (Lucent Connector)
  Link length support: 10km(smf)
  Wavelength: 1310.00 nm
  Capabilities: [Tx-Disable, Diagnostic Monitoring, Transmitter Power Measurement, Receiver Power
Measurement(AVG)]
  Manufactured date: Fri Feb 28 00:00:00 GMT +0000 2020
  Temperature parameters:
    Temperature: 33.75 °C
    Temperature low warning: False (threshold: 0.00 °C)
    Temperature low alarm: False (threshold: -5.00 °C)
    Temperature high warning: False (threshold: 70.00°C)
    Temperature high alarm: False (threshold: 75.00 °C)
  Voltage parameters:
    Voltage: 3.32 V
    Voltage low warning: False (threshold: 3.10 V)
    Voltage low alarm: False (threshold: 3.00 V)
    Voltage high warning: False (threshold: 3.50V)
    Voltage high alarm: False (threshold: 3.60 V)
  Lane Id: 0
    Interrupt parameters:
      Tx disable: False
      Laser Tx loss of signal: False
      Laser Tx loss of lock: False
      Laser Rx loss of signal: False
      Laser Rx loss of lock: False
    Laser bias current parameters:
      Laser bias current: 49.118 mA
      Laser bias current low warning: False (threshold: 35.00 mA)
      Laser bias current low alarm: False (threshold: 30.00 mA)
      Laser bias current high warning: False (threshold: 60.00 mA)
      Laser bias current high alarm: False (threshold: 65.00 mA)
    Laser Tx power parameters:
      Laser Tx power: 1.502 mW / 1.768 dbm
      Laser Tx Power low warning: False (threshold: 0.37 mW / -4.30 dbm)
      Laser Tx Power low alarm: False (threshold: 0.30 mW / -5.30 dbm)
      Laser Tx Power high warning: False (threshold: 2.82 mW / 4.50 dbm)
      Laser Tx Power high alarm: False (threshold: 3.55 mW / 5.50 dbm)
    Laser Rx power parameters:
      Laser Rx power: 0.985 mW / -0.066 dbm
      Laser Rx Power low warning: False (threshold: 0.09 mW / -10.60 dbm)
      Laser Rx Power low alarm: False (threshold: 0.07 mW / -11.60 dbm)
      Laser Rx Power high warning: False (threshold: 2.82 mW / 4.50 dbm)
      Laser Rx Power high alarm: False (threshold: 3.55 mW / 5.50 dbm)
  Lane Id: 1
    Interrupt parameters:
      Tx disable: False
      Laser Tx loss of signal: False
      Laser Tx loss of lock: False
      Laser Rx loss of signal: False
      Laser Rx loss of lock: False
```

```
    Laser bias current parameters:
      Laser bias current: 49.126 mA
      Laser bias current low warning: False (threshold: 35.00 mA)
      Laser bias current low alarm: False (threshold: 30.00 mA)
      Laser bias current high warning: False (threshold: 60.00 mA)
      Laser bias current high alarm: False (threshold: 65.00 mA)
    Laser Tx power parameters:
      Laser Tx power: 1.624 mW / 2.105 dbm
      Laser Tx Power low warning: False (threshold: 0.37 mW / -4.30 dbm)
      Laser Tx Power low alarm: False (threshold: 0.30 mW / -5.30 dbm)
      Laser Tx Power high warning: False (threshold: 2.82 mW / 4.50 dbm)
      Laser Tx Power high alarm: False (threshold: 3.55 mW / 5.50 dbm)
    Laser Rx power parameters:
      Laser Rx power: 0.94 mW / -0.271 dbm
      Laser Rx Power low warning: False (threshold: 0.09 mW / -10.60 dbm)
      Laser Rx Power low alarm: False (threshold: 0.07 mW / -11.60 dbm)
      Laser Rx Power high warning: False (threshold: 2.82 mW / 4.50 dbm)
      Laser Rx Power high alarm: False (threshold: 3.55 mW / 5.50 dbm)
  Lane Id: 2
    Interrupt parameters:
      Tx disable: False
      Laser Tx loss of signal: False
      Laser Tx loss of lock: False
      Laser Rx loss of signal: False
      Laser Rx loss of lock: False
    Laser bias current parameters:
      Laser bias current: 49.134 mA
      Laser bias current low warning: False (threshold: 35.00 mA)
      Laser bias current low alarm: False (threshold: 30.00 mA)
      Laser bias current high warning: False (threshold: 60.00 mA)
      Laser bias current high alarm: False (threshold: 65.00 mA)
    Laser Tx power parameters:
      Laser Tx power: 1.304 mW / 1.151 dbm
      Laser Tx Power low warning: False (threshold: 0.37 mW / -4.30 dbm)
      Laser Tx Power low alarm: False (threshold: 0.30 mW / -5.30 dbm)
      Laser Tx Power high warning: False (threshold: 2.82 mW / 4.50 dbm)
      Laser Tx Power high alarm: False (threshold: 3.55 mW / 5.50 dbm)
    Laser Rx power parameters:
      Laser Rx power: 1.018 mW / 0.077 dbm
      Laser Rx Power low warning: False (threshold: 0.09 mW / -10.60 dbm)
      Laser Rx Power low alarm: False (threshold: 0.07 mW / -11.60 dbm)
      Laser Rx Power high warning: False (threshold: 2.82 mW / 4.50 dbm)
      Laser Rx Power high alarm: False (threshold: 3.55 mW / 5.50 dbm)
  Lane Id: 3
    Interrupt parameters:
      Tx disable: False
      Laser Tx loss of signal: False
      Laser Tx loss of lock: False
      Laser Rx loss of signal: False
      Laser Rx loss of lock: False
    Laser bias current parameters:
      Laser bias current: 49.142 mA
      Laser bias current low warning: False (threshold: 35.00 mA)
      Laser bias current low alarm: False (threshold: 30.00 mA)
      Laser bias current high warning: False (threshold: 60.00 mA)
      Laser bias current high alarm: False (threshold: 65.00 mA)
    Laser Tx power parameters:
      Laser Tx power: 1.577 mW / 1.979 dbm
      Laser Tx Power low warning: False (threshold: 0.37 mW / -4.30 dbm)
      Laser Tx Power low alarm: False (threshold: 0.30 mW / -5.30 dbm)
      Laser Tx Power high warning: False (threshold: 2.82 mW / 4.50 dbm)
      Laser Tx Power high alarm: False (threshold: 3.55 mW / 5.50 dbm)
    Laser Rx power parameters:
      Laser Rx power: 0.958 mW / -0.188 dbm
      Laser Rx Power low warning: False (threshold: 0.09 mW / -10.60 dbm)
      Laser Rx Power low alarm: False (threshold: 0.07 mW / -11.60 dbm)
      Laser Rx Power high warning: False (threshold: 2.82 mW / 4.50 dbm)
      Laser Rx Power high alarm: False (threshold: 3.55 mW / 5.50 dbm)
Interface name: ifp-0/1/71
  Transceiver name: 100GBASE-LR4
  Vendor name: FS
  Module type: QSFP28
  Serial number: G1809186114
  Part number: QSFP28-IR4-100G
  Material number: n/a
  Power class: 6(4.5W)
  Power class mode: HIGH
```

```
  Connector type: LC (Lucent Connector)
  Link length support: 2km(smf)
  Wavelength: 1310.00 nm
  Capabilities: [Tx-Disable, Diagnostic Monitoring, Extended Rate Select, Transmitter Power Measurement,
Receiver Power Measurement(AVG)]
  Manufactured date: Wed Oct 24 00:00:00 GMT +0000 2018
  Temperature parameters:
    Temperature: 29.30 °C
    Temperature low warning: False (threshold: -5.00 °C)
    Temperature low alarm: False (threshold: -10.00 °C)
    Temperature high warning: False (threshold: 75.00°C)
    Temperature high alarm: False (threshold: 80.00 °C)
  Voltage parameters:
    Voltage: 3.38 V
    Voltage low warning: False (threshold: 3.00 V)
    Voltage low alarm: False (threshold: 2.90 V)
    Voltage high warning: False (threshold: 3.60V)
    Voltage high alarm: False (threshold: 3.70 V)
  Lane Id: 0
    Interrupt parameters:
      Tx disable: False
      Laser Tx loss of signal: False
      Laser Tx loss of lock: False
      Laser Rx loss of signal: True
      Laser Rx loss of lock: False
    Laser bias current parameters:
      Laser bias current: 33.152 mA
      Laser bias current low warning: False (threshold: 15.00 mA)
      Laser bias current low alarm: False (threshold: 10.00 mA)
      Laser bias current high warning: False (threshold: 70.00 mA)
      Laser bias current high alarm: False (threshold: 75.00 mA)
    Laser Tx power parameters:
      Laser Tx power: 1.218 mW / 0.857 dbm
      Laser Tx Power low warning: False (threshold: 0.18 mW / -7.50 dbm)
      Laser Tx Power low alarm: False (threshold: 0.14 mW / -8.50 dbm)
      Laser Tx Power high warning: False (threshold: 2.24 mW / 3.50 dbm)
      Laser Tx Power high alarm: False (threshold: 2.82 mW / 4.50 dbm)
    Laser Rx power parameters:
      Laser Rx power: 0.0 mW / -30.0 dbm
      Laser Rx Power low warning: True (threshold: 0.06 mW / -12.50 dbm)
      Laser Rx Power low alarm: True (threshold: 0.04 mW / -14.50 dbm)
      Laser Rx Power high warning: False (threshold: 2.24 mW / 3.50 dbm)
      Laser Rx Power high alarm: False (threshold: 2.82 mW / 4.50 dbm)
  Lane Id: 1
    Interrupt parameters:
      Tx disable: False
      Laser Tx loss of signal: False
      Laser Tx loss of lock: False
      Laser Rx loss of signal: False
      Laser Rx loss of lock: False
    Laser bias current parameters:
      Laser bias current: 35.456 mA
      Laser bias current low warning: False (threshold: 15.00 mA)
      Laser bias current low alarm: False (threshold: 10.00 mA)
      Laser bias current high warning: False (threshold: 70.00 mA)
      Laser bias current high alarm: False (threshold: 75.00 mA)
    Laser Tx power parameters:
      Laser Tx power: 1.238 mW / 0.925 dbm
      Laser Tx Power low warning: False (threshold: 0.18 mW / -7.50 dbm)
      Laser Tx Power low alarm: False (threshold: 0.14 mW / -8.50 dbm)
      Laser Tx Power high warning: False (threshold: 2.24 mW / 3.50 dbm)
      Laser Tx Power high alarm: False (threshold: 2.82 mW / 4.50 dbm)
    Laser Rx power parameters:
      Laser Rx power: 0.458 mW / -3.388 dbm
      Laser Rx Power low warning: False (threshold: 0.06 mW / -12.50 dbm)
      Laser Rx Power low alarm: False (threshold: 0.04 mW / -14.50 dbm)
      Laser Rx Power high warning: False (threshold: 2.24 mW / 3.50 dbm)
      Laser Rx Power high alarm: False (threshold: 2.82 mW / 4.50 dbm)
  Lane Id: 2
    Interrupt parameters:
      Tx disable: False
      Laser Tx loss of signal: False
      Laser Tx loss of lock: False
      Laser Rx loss of signal: False
      Laser Rx loss of lock: False
    Laser bias current parameters:
      Laser bias current: 35.2 mA
```

```
      Laser bias current low warning: False (threshold: 15.00 mA)
      Laser bias current low alarm: False (threshold: 10.00 mA)
      Laser bias current high warning: False (threshold: 70.00 mA)
      Laser bias current high alarm: False (threshold: 75.00 mA)
    Laser Tx power parameters:
      Laser Tx power: 1.085 mW / 0.353 dbm
      Laser Tx Power low warning: False (threshold: 0.18 mW / -7.50 dbm)
      Laser Tx Power low alarm: False (threshold: 0.14 mW / -8.50 dbm)
      Laser Tx Power high warning: False (threshold: 2.24 mW / 3.50 dbm)
      Laser Tx Power high alarm: False (threshold: 2.82 mW / 4.50 dbm)
    Laser Rx power parameters:
      Laser Rx power: 0.664 mW / -1.776 dbm
      Laser Rx Power low warning: False (threshold: 0.06 mW / -12.50 dbm)
      Laser Rx Power low alarm: False (threshold: 0.04 mW / -14.50 dbm)
      Laser Rx Power high warning: False (threshold: 2.24 mW / 3.50 dbm)
      Laser Rx Power high alarm: False (threshold: 2.82 mW / 4.50 dbm)
  Lane Id: 3
    Interrupt parameters:
      Tx disable: False
      Laser Tx loss of signal: False
      Laser Tx loss of lock: False
      Laser Rx loss of signal: True
      Laser Rx loss of lock: False
    Laser bias current parameters:
      Laser bias current: 32.384 mA
      Laser bias current low warning: False (threshold: 15.00 mA)
      Laser bias current low alarm: False (threshold: 10.00 mA)
      Laser bias current high warning: False (threshold: 70.00 mA)
      Laser bias current high alarm: False (threshold: 75.00 mA)
    Laser Tx power parameters:
      Laser Tx power: 0.694 mW / -1.588 dbm
      Laser Tx Power low warning: False (threshold: 0.18 mW / -7.50 dbm)
      Laser Tx Power low alarm: False (threshold: 0.14 mW / -8.50 dbm)
      Laser Tx Power high warning: False (threshold: 2.24 mW / 3.50 dbm)
      Laser Tx Power high alarm: False (threshold: 2.82 mW / 4.50 dbm)
    Laser Rx power parameters:
      Laser Rx power: 0.0 mW / -30.0 dbm
      Laser Rx Power low warning: True (threshold: 0.06 mW / -12.50 dbm)
      Laser Rx Power low alarm: True (threshold: 0.04 mW / -14.50 dbm)
      Laser Rx Power high warning: False (threshold: 2.24 mW / 3.50 dbm)
      Laser Rx Power high alarm: False (threshold: 2.82 mW / 4.50 dbm)
```

Resetting the Optical Transceiver Manually

The reset transceiver operational command allows users to manually reset an optical transceiver on a specified interface.

Syntax:

reset transceiver interface <interface>

Attribute	Description
<interface>	Name of the physical interface.

The following example shows how to manually reset the optical transceiver on the specified interface, 'ifp-0/1/64'. In this command:

- For QSFP transceivers, a hardware reset signal is sent via I2C to reset the

transceiver hardware.

- Port disable and enable are performed.

```
supervisor@rtbrick: op> reset transceiver interface ifp-0/1/64
  Transceiver ifp-0/1/64 hardware reset signal sent via I2C
  Initiating state transition (down/up) on port ifp-0/1/64 (bcm port 65)
  Port ifp-0/1/64 administrative state set to down
  Port ifp-0/1/64 (bcm port 65) administrative state set to up
```

Disk Details

This command displays disk information.

Syntax:

show disk <option>

Option	Description
summary	Displays the disk information.
usage	Displays the disk usage information.

Example: Summary of disks and their partitions.

```
supervisor@rtbrick: op> show disk summary
sda
  Size    : 29.8G
  Vendor  : ATA
  Model   : TS32ZBTMM1600
  Partitions
  Name               Size        Mountpoint
  sda1               256M        n/a
  sda2               128M        n/a
  sda3               2G          n/a
  sda4               128M        n/a
  sda5               128M        n/a
  sda6               2G          n/a
  sda7               25.2G       /platform
supervisor@rtbrick: op>
```

Example 2: Summary of disk usage information.

```
supervisor@rtbrick: op> show disk usage
Filesystem              Type            Size        Used        Available    Mountpoint          Usage %
none                    tmpfs           492 KB      0 bytes     492 KB       /dev                0.0
tmpfs                   tmpfs           8.15 GB     17.38 MB    8.13 GB      /run                0.21
```

```
tmpfs                   tmpfs           6.29 GB     483.6 MB    5.81 GB     /shm                7.69
tmpfs                   tmpfs           8.15 GB     62.74 MB    8.09 GB     /dev/shm            0.77
tmpfs                   tmpfs           5.12 MB     0 bytes     5.12 MB     /run/lock           0.0
devtmpfs                devtmpfs        1.02 MB     0 bytes     1.02 MB     /dev/mem            0.0
/dev/sda7               ext4            25.87 GB    4.47 GB     20.06 GB    /var/log            18.21
tmpfs                   tmpfs           1.63 GB     0 bytes     1.63 GB     /run/user/1000      0.0
tmpfs                   tmpfs           8.15 GB     0 bytes     8.15 GB     /sys/fs/cgroup      0.0
tmpfs                   tmpfs           1.63 GB     696 KB      1.63 GB     /var/run-ext/onl/r  0.04
/var/cache/rtbrick/imag overlay         25.87 GB    4.47 GB     20.06 GB    /                   18.21
supervisor@rtbrick: op>
```

Platform Details

This command displays platform information.

Syntax:

```
show platform
```

Example: Platform information

```
supervisor@rtbrick: op> show platform
x86_64-accton_as7316_26xb-r0
  Vendor                : Edgecore
  Manufacturer          : Accton
  Manufacture date      : 05/07/2021 16:55:51
  MAC address           : 90:3c:b3:16:00:00
  Part number           : F0PZZ5626002A-MACDDR-Nanya_NT5AD256M16D4_HRI
  Serial number         : ABC1234ABCD
  Product name          : 7316-26XB-O-AC-F
  Onie version          : 2019.11.00.07
  Label revision        : R01C
  Diag version          : 01.01.00.03
  Country code          : TW
supervisor@rtbrick: op>
```

Hardware Resource Usage Information

The command show hardware resource monitor displays the hardware consumption information for the various resources.

Syntax:

```
show hardware resource monitor
```

Example: Hardware resource monitoring information

```
supervisor@rtbrick.net: op> show hardware resource monitor
  Resource Type                                          Consumed Estimated
  ECMP_GROUP                                                    0     40960
  EEDB_ARP                                                     14     81920
  EEDB_IPV4_TUNNEL                                              0     81920
  EEDB_IPV6_TUNNEL                                              0     81920
  EEDB_L2TP                                                     0     81920
  EEDB_MPLS_TUNNEL                                              0     81920
  EEDB_PPPOE                                                    0     81920
  EEDB_PWE                                                      0     81920
  IN_AC_C_C_VLAN_DB                                             0    142046
  IN_AC_C_VLAN_DB                                              12    142046
  IN_AC_S_C_VLAN_DB                                             0    142046
  IN_AC_S_VLAN_DB                                               0    142046
  IN_AC_UNTAGGED_DB                                             1    142046
  IN_LIF_FORMAT_PWE                                             0     98304
  IPV4_MULTICAST_PRIVATE_LPM_FORWARD                            0    947200
  IPV4_MULTICAST_TCAM_FORWARD                                   0     75776
  IPV4_TT_P2P_EM_BASIC                                          0     57507
  IPV4_UNICAST_PRIVATE_LPM_FORWARD                             28   1894400
  IPV4_UNICAST_PRIVATE_LPM_FORWARD_2                            0         0
  IPV6_TT_P2P_EM_BASIC                                          0     57507
  IPV6_UNICAST_PRIVATE_LPM_FORWARD                             10    947200
  IPV6_UNICAST_PRIVATE_LPM_FORWARD_2                            0         0
  KBP_IPV4_UNICAST_PRIVATE_LPM_FORWARD                          0         0
  KBP_IPV4_UNICAST_PRIVATE_LPM_RPF                              0         0
  KBP_IPV6_UNICAST_PRIVATE_LPM_FORWARD                          0         0
  KBP_IPV6_UNICAST_PRIVATE_LPM_RPF                              0         0
  KBP_NAT_EXTERNAL_TO_INTERNAL                                  0   7143232
  KBP_NAT_EXTERNAL_TO_INTERNAL_STATS                            0   4039065
  KBP_NAT_INTERNAL_TO_EXTERNAL                                  0   7143232
  KBP_NAT_INTERNAL_TO_EXTERNAL_STATS                            0   4039065
  L2TPV2_DATA_MESSAGE_TT                                        0    123534
  L3V4_EXTERNAL                                                21      2048
  L3V6_EXTERNAL                                                 6      1024
  L3_RIF                                                       17     73727
  MFV4_EXTERNAL                                                 4      2048
  MFV6_EXTERNAL                                                 0      1024
  MPLS_FWD                                                      0    186777
  MPLS_TERMINATION_SINGLE_LABEL_DB                              5    123534
  MULTICAST_MCDB                                                1    262142
  POLICER_EXTERNAL                                              0      4096
  PPPOE_O_ETH_TUNNEL_FULL_SA                                    0     57507
  QOS_CL_ELEMENTS                                               0     30000
  QOS_EGRESS_PROFILE_TO_INTERNAL_MAP                           11       256
  QOS_FQ_ELEMENTS                                               0     30000
  QOS_HR_ELEMENTS                                             170     30000
  QOS_INGRESS_PHB_PROFILE_TO_INTERNAL_MAP                       9      9216
  QOS_MC_QUEUE_BUNDLES                                          1     32000
  QOS_SCH_SHARED_SHAPER_DUAL                                    2     30000
  QOS_SCH_SHARED_SHAPER_OCTA                                    0     30000
  QOS_SCH_SHARED_SHAPER_QUAD                                    0     30000
  QOS_UC_QUEUE_BUNDLES                                        107     32000
  QOS_VOQ_CONNECTOR_BUNDLES                                    22     32000
```

Error Message Indicator for Transceiver

An error indicator in the output of the show transceiver <ifp-name> and show interface <ifp-name> commands. It flags an error message for broken or faulty transceivers or when the transceiver EEPROM is corrupted or cannot be read. It allows for quick fault identification without the need for additional diagnostic steps.

The following is a show command output displays an indicator for the specified transceiver 'ifp-0/1/10'.

```
supervisor@rtbrick.net: cfg> show transceiver ifp-0/1/10
ifp-0/1/10
  Transceiver name: n/a, Vendor name: n/a, Module type: Unknown(Transceiver-EEPROM
corruption/read-failure), Serial number: n/a
  Part number: n/a, Material number: n/a
  Power class: n/a
  Connector type: n/a, Link length support: n/a  Manufactured date: n/a
```

10.3. SNMP

10.3.1. SNMP Overview

SNMP (Simple Network Management Protocol) provides a network monitoring mechanism that collects state information from various network devices and components. The protocol enables you to monitor the RBFS network and detect network faults on remote devices.

SNMP can monitor interfaces, CPU usage, temperature of the device, bandwidth usage, and so on. For example, if an interface goes down on one of the devices, SNMP can quickly alert the change.

Understanding RBFS SNMP Implementation

The RBFS SNMP implementation allows retrieving system state information using the Protocol Data Unit (PDU) from various network components. SNMP defines system objects in Management Information Bases (MIBs), where each object forms a Protocol Data Unit (PDU).

A device that is SNMP enabled is known as SNMP agent. SNMP agent collects information from various devices and components and stores the data within MIB. An SNMP agent includes several objects such as interfaces and routing tables

which can be interacted with. Every object has a unique identifier which is known as OID (Object Identifier). OIDs provide a unique identity for managed objects in an MIB hierarchy.

RBFS implements the SNMP daemon (snmpd) that maps the operational state API to SNMP MIBs for retrieving system state data.

SNMP Operations

SNMP allows performing various operations that include GET for retrieving data, SET for modifying data, TRAP for notifying an event and so on. These operations provide management access to the MIB hierarchy.

1. **GET**: The SNMP GET operation retrieves data from the managed device's MIB.
2. **GETNEXT**: The GETNEXT operation retrieves data for the next object from the tree of objects on the device.
3. **SET**: The SNMP SET operation allows modifying data for a device.
4. **TRAP**: Event notification that is not requested.



RBFS does not currently support the SNMP SET operation.

Supported SNMP MIBs

Management Information Base (MIB) is a collection of data that is organized hierarchically. You can define an MIB mapping for the supported MIBs. This MIB mapping provides a way to retrieve the required state information using the Operational State API or any other RBFS API or Prometheus.

Currently, RBFS supports two SNMP MIBs: the Interface MIB and the Host Resources MIBs.

- **Host Resources MIB**: Provides information about system resources on the host machine, such as CPU, memory, and storage. For details, see https://www.net-snmp.org/docs/mibs/HOST-RESOURCES-MIB.txt.
- **Interfaces MIB**: Provides information about the status and statistics of network interfaces. For details, see https://www.net-snmp.org/docs/mibs/IF-MIB.txt.
- **System MIB**: Supplies general device information, including system name, hardware details, and the installed network operating system version.

https://www.net-snmp.org/docs/mibs/RFC1213-MIB.txt.

Supported SNMP Versions

RBFS supports the SNMP version 2c and SNMP version 3. SNMP version 3 provides support for authentication and encryption and the data can be accessed after capture only by authorized users. You must choose either version 2c or version 3 before configuring other functionalities.

Information about SNMP v2c and v3

SNMP v2c allows access control through Communities, but the community information is not protected. Anyone with the community name can access all the information available for that community.

SNMP v3 provides a higher level of security using authentication and privacy protocols. RBFS supports the user-based security model defined in RFC 3414.

The user credentials verify the authenticity and integrity of the message by adding message authentication codes (MACs) to the SNMP packet. The privacy protocol allows for the encryption of the transmitted data.

Supported Platforms

Not all features are necessarily supported on each hardware platform. Refer to the *Platform Guide* for the features and the sub-features that are or are not supported by each platform.

10.3.2. SNMP Configuration

By default, SNMP is not enabled. To enable SNMP, you must complete the SNMP configurations.

RBFS supports SNMP 2c and 3 versions. You must first configure the desired version before configuring other functionalities. RBFS does not support running both the SNMP 2c and 3 versions at the same time.

The RBFS CLI displays all options regardless of the selected version. Even though functionalities such as Community can be configured for both of the versions, it works only in SNMP 2c version. You can define 'user profiles' on SNMP v3 and 'Community' in version 2c. Similarly, Engine ID can be defined in SNMP version 3.

Configuration Hierarchy

The diagram illustrates the SNMP configuration hierarchy. All SNMP configurations are performed within an instance.

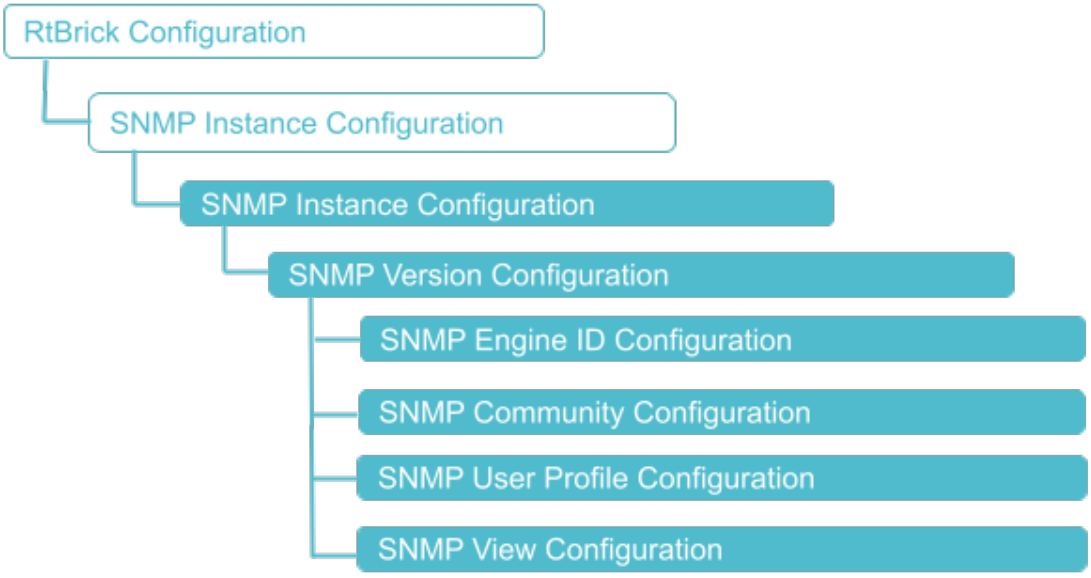


Figure 160. SNMP Configuration Hierarchy

Configuration Syntax and Commands

The following sections describe the SNMP configuration syntax and commands.

SNMP Instance Configuration

At this instance configuration hierarchy, you configure SNMP protocol parameters which are generic to the SNMP instance.

Syntax

set instance <instance-name> **protocol snmp** <attribute> <value>

Attribute	Description
version	Specify the SNMP version. RBFS supports SNMP version 2c and version 3. You must first configure the desired version before configuring other functionalities.
engine-id	Specify the unique SNMP engine identifier. This is optional. If not specified, the system retrieves the default engine ID from the management port MAC address. Every SNMP v3 agent includes an engine ID that is a unique identifier for the agent. The engine ID is used to provide a higher level of security using authentication and encryption for SNMP v3 messages.

Example: SNMP Version and Engine Identifier Configuration

The following commands configure SNMP version 3 and engine ID: 268956.

```
set instance default protocol snmp version 3
set instance default protocol snmp engine-id 268956
```

The following example shows the SNMP version and engine ID configurations.

```
supervisor@rtbrick.net: cfg> show config instance default protocol snmp
{
  "rtbrick-config:snmp": {
    "version": "3",
    "engine-id": "268956"
  }
}
```

API To access the RESTCONF API that corresponds to this CLI, click here.

SNMP Community Configuration

An SNMP community can be defined only in the SNMP version 2c.

Syntax

set instance <instance-name> **protocol snmp community**

Attribute	Description
access-mode	Specify the access mode. Read, write and append are modes of access. 'ReadOnly' is the currently supported access mode.
view	Specify the list of view identifiers. View is optional. For information about Views, see section "2.2.3 SNMP View Configuration".

Example: SNMP v2c Community Configuration

The following commands configure a Community named 'public' with read-only access right to the 'interfaces' View.

```
set instance default protocol snmp version 2c
set instance default protocol snmp community public access-mode ReadOnly
set instance default protocol snmp community public view Interfaces
```

The following example shows SNMP v2c community configurations.

```
supervisor@rtbrick: cfg> show config instance default protocol snmp
{
  "rtbrick-config:snmp": {
    "version": "2c",
    "community": [
      {
        "name": "public"
        "access-mode": "ReadOnly"
      }
    ]
  }
}
```

API To access the RESTCONF API that corresponds to this CLI, click here.

SNMP View Configuration

An SNMP View is a subset of MIB objects. Views allow you to restrict access to certain items in the SNMP PDUs. You can restrict user and community access to certain attributes by defining views. A view restricts access to the PDUs included in the View. If the access is not restricted by views, the user or community is allowed

to view all data available through SNMP.

Syntax

set instance <instance-name> **protocol snmp** <attribute> <value>

Attribute	Description
include <include>	List of OID patterns that are included in the view.
instance	List of instances. It restricts the view to the specified instances. If no instance is defined, the view can access to all instances.

Example: SNMP View Configuration

The following commands configure SNMP View. In this example configuration, SNMP version has been specified as 2c and 'View' name is specified as interfaces. The 'interfaces' view includes the OID 1.3.6.1.2.1.2.* in the view list. In addition, the configuration shows a user 'community' named public has been configured and the community has read-only access to the View.

```
set instance default protocol snmp version 2c
set instance default protocol snmp view interfaces include 1.3.6.1.2.1.2.*
set instance default protocol snmp community public access-mode ReadOnly
```

The following example shows the SNMP View configuration.

```
supervisor@rtbrick: cfg> show config instance default protocol snmp
{
  "rtbrick-config:snmp": {
    "version": "2c",
    "view": [
      {
        "name": "interfaces",
        "include": [
          "1.3.6.1.2.1.2.*"
          ]
      }
    ],
    "community": [
      {
        "name": "public",
        "access-mode": "ReadOnly",
        "view": [
          "interfaces"
```

```
          ]
        }
      ]
    }
  }
```

To access the RESTCONF API that corresponds to this CLI, click here.

SNMP Trap Configuration

The trap is a notification about a specific condition or event that occurs on the device. RBFS supports event notifications for events: link up and link down. Unlike other PDU types, a trap is a notification that is sent without any request from the SNMP manager.

Syntax

set instance <instance-name> **protocol snmp trap** <trap-name> <attribute> <value>

Attribute	Description
community	Community is supported in SNMPv2c only. Specify the 'Community' to enable trap notification for SNMPv2c.
include	List of OIDs that are included for the trap notifications.
instance	Specify the instance.
trap-receiver	Specify trap receiver device.
user-profile	User profile is supported on SNMPv3 only. Specify the 'user profile' to enable trap notification for SNMPv3.

To access the RESTCONF API that corresponds to this CLI, click here.

SNMP User Profile Configuration

You can create user profiles for SNMP version 3. It allows you to define login credentials, authentication methods, and privacy control.

Syntax

set instance <instance-name> **protocol snmp user-profile**

Attribute	Description
authentication-protocol	Specify SNMP authentication protocol. MD5, NoAuth, SHA, SHA224, SHA256, SHA384, and SHA512 are the supported authentication protocol.
password-encrypted-text	Specify SNMP user password in encrypted text.
password-plain-text	Specify SNMP user password in plain text.
privacy-password-encrypted-text	Specify SNMP privacy password in encrypted text.
privacy-password-plain-text	Specify SNMP privacy password in plain text.
privacy-protocol	Specify SNMP privacy protocol. Supported privacy protocols include AES192, AES192C, AES256, AES256C, DES, and NoPriv.
security-level	Specify SNMP v3 security level. Security levels exist only in SNMP v3. The following security levels are supported: • noAuthNoPriv: no authentication, no privacy • authNoPriv: authentication, no privacy • authPriv: authentication, privacy
view	Specify SNMP view list.

Example: SNMP User Profile Configuration

The following commands configure SNMP user profile. At first, SNMP Version 3 is configured with the user profile name as operator. Password type has been selected as password encrypted text. In this configuration, the security level is configured as AuthNoPriv and MD5 as type of the authentication protocol.

```
set instance default protocol snmp version 3
set instance default protocol snmp user-profile operator
set instance default protocol snmp user-profile operator password-encrypted-text
```

```
$2a6fd7db50a18a9f1f16b5c5b4214fab0
set instance default protocol snmp user-profile operator security-level AuthNoPriv
set instance default protocol snmp user-profile operator authentication-protocol
MD5
```

The following example shows the SNMP User Profile Configuration

```
supervisor@rtbrick: cfg> show config instance default protocol snmp
{
  "rtbrick-config:snmp": {
    "version": "3",
    "user-profile": [
      {
        "name": "operator",
        "password-encrypted-text": "$2a6fd7db50a18a9f1f16b5c5b4214fab0",
        "security-level": "AuthNoPriv",
        "authentication-protocol": "MD5"
      }
    ]
  }
}
```

 To access the RESTCONF API that corresponds to this CLI, click here.

SNMP Location Configuration

With the Location option, you can configure basic administrative information such as the physical location for a managed device.

Syntax

set instance <instance-name> **protocol snmp location** <location-name>

Example Command:

```
set instance default protocol snmp location BLR
```

SNMP Contact Configuration

With the SNMP Contact option, you can configure basic administrative information for a managed device. You can specify the contact information of the person responsible for the device.

Syntax

set instance <instance-name> **protocol snmp contact** <contact-name>

Example Command:

```
set instance default protocol snmp contact RtBrick
```

Examples for SNMP Walk Operation

SNMP v2c SNMP Walk Output

The following is a sample output for the SNMP Walk for SNMP version 2c. SNMP version 2c has been configured with Community name as 'public' and, host IP address as 10.200.134.25.

```
snmpwalk -v 2c -c public 10.200.134.25
iso.3.6.1.2.1.2.2.1.1.1 = INTEGER: 1
iso.3.6.1.2.1.2.2.1.1.2 = INTEGER: 2
iso.3.6.1.2.1.2.2.1.1.3 = INTEGER: 3
iso.3.6.1.2.1.2.2.1.1.4 = INTEGER: 4
iso.3.6.1.2.1.2.2.1.1.5 = INTEGER: 5
iso.3.6.1.2.1.2.2.1.1.6 = INTEGER: 6
iso.3.6.1.2.1.2.2.1.1.7 = INTEGER: 7
iso.3.6.1.2.1.2.2.1.1.8 = INTEGER: 8
iso.3.6.1.2.1.2.2.1.1.9 = INTEGER: 9
iso.3.6.1.2.1.2.2.1.1.10 = INTEGER: 10
iso.3.6.1.2.1.2.2.1.1.11 = INTEGER: 11
iso.3.6.1.2.1.2.2.1.1.12 = INTEGER: 12
iso.3.6.1.2.1.2.2.1.1.13 = INTEGER: 13
iso.3.6.1.2.1.2.2.1.1.14 = INTEGER: 14
iso.3.6.1.2.1.2.2.1.1.15 = INTEGER: 15
iso.3.6.1.2.1.2.2.1.1.16 = INTEGER: 16
iso.3.6.1.2.1.2.2.1.1.17 = INTEGER: 17
iso.3.6.1.2.1.2.2.1.1.18 = INTEGER: 18
iso.3.6.1.2.1.2.2.1.1.19 = INTEGER: 19
iso.3.6.1.2.1.2.2.1.1.20 = INTEGER: 20
iso.3.6.1.2.1.2.2.1.1.21 = INTEGER: 21
iso.3.6.1.2.1.2.2.1.1.22 = INTEGER: 22
iso.3.6.1.2.1.2.2.1.1.23 = INTEGER: 23
<...>
```

SNMP v3 SNMP Walk Output

The following is a sample output for the SNMP Walk for SNMP version 3. SNMP version 3 has been configured with user as 'operator', MD5 as the authentication

protocol, authNoPriv as the security level, and 10.200.134.25 as the host IP address.

```
snmpwalk -v 3 -u operator -A operator -a MD5 -l authNoPriv 10.200.134.25
iso.3.6.1.2.1.2.2.1.1.1 = INTEGER: 1
iso.3.6.1.2.1.2.2.1.1.2 = INTEGER: 2
iso.3.6.1.2.1.2.2.1.1.3 = INTEGER: 3
iso.3.6.1.2.1.2.2.1.1.4 = INTEGER: 4
iso.3.6.1.2.1.2.2.1.1.5 = INTEGER: 5
iso.3.6.1.2.1.2.2.1.1.6 = INTEGER: 6
iso.3.6.1.2.1.2.2.1.1.7 = INTEGER: 7
iso.3.6.1.2.1.2.2.1.1.8 = INTEGER: 8
iso.3.6.1.2.1.2.2.1.1.9 = INTEGER: 9
iso.3.6.1.2.1.2.2.1.1.10 = INTEGER: 10
iso.3.6.1.2.1.2.2.1.1.11 = INTEGER: 11
iso.3.6.1.2.1.2.2.1.1.12 = INTEGER: 12
iso.3.6.1.2.1.2.2.1.1.13 = INTEGER: 13
iso.3.6.1.2.1.2.2.1.1.14 = INTEGER: 14
iso.3.6.1.2.1.2.2.1.1.15 = INTEGER: 15
iso.3.6.1.2.1.2.2.1.1.16 = INTEGER: 16
iso.3.6.1.2.1.2.2.1.1.17 = INTEGER: 17
iso.3.6.1.2.1.2.2.1.1.18 = INTEGER: 18
iso.3.6.1.2.1.2.2.1.1.19 = INTEGER: 19
iso.3.6.1.2.1.2.2.1.1.20 = INTEGER: 20
iso.3.6.1.2.1.2.2.1.1.21 = INTEGER: 21
iso.3.6.1.2.1.2.2.1.1.22 = INTEGER: 22
iso.3.6.1.2.1.2.2.1.1.23 = INTEGER: 23
<...>
```

The following is a sample output for the SNMP System MIB walk operation.

```
snmpwalk -v 2c -c ufi17.q2c.u34.r6.nbg.rtbrick.net"
<...>
iso.3.6.1.2.1.1.1 = STRING: "UfiSpace S9600-102XC-R, RBFS 24.9.0-
g6daily.20241007154425+Bdevelopment.C8e6a3a56"
iso.3.6.1.2.1.1.2 = OID: iso.3.6.1.4.1.50058.1.1
iso.3.6.1.2.1.1.3 = Timeticks: (35079) 0:05:50.79
iso.3.6.1.2.1.1.4 = ""
iso.3.6.1.2.1.1.5 = STRING: "ufi17.q2c.u34.r6.nbg.rtbrick.net"
iso.3.6.1.2.1.1.6 = ""
iso.3.6.1.2.1.1.7 = INTEGER: 12
iso.3.6.1.2.1.1.7 = No more variables left in this MIB View (It is past the end
of the MIB tree)
<...>
```

Example 2:

```
snmpwalk -v 2c -c rbfs ufi11.q2a.u15.r6.nbg.rtbrick.net
iso.3.6.1.2.1.1.1 = STRING: "Ufi Space S9510-28DC-B, RBFS 25.1.0-
g6daily.20250415154806+Bdevelopment.Cdf3d9037"
iso.3.6.1.2.1.1.2 = OID: iso.3.6.1.4.1.50058.1.1
iso.3.6.1.2.1.1.3 = Timeticks: (41382) 0:06:53.82
iso.3.6.1.2.1.1.4 = STRING: "RtBrick"
iso.3.6.1.2.1.1.5 = STRING: "ufi11.q2a.u15.r6.nbg.rtbrick.net"
```

```
iso.3.6.1.2.1.1.6 = STRING: "BLR"
iso.3.6.1.2.1.1.7 = INTEGER: 12
iso.3.6.1.2.1.1.7 = No more variables left in this MIB View (It is past the end of
the MIB tree)
```

11. Infrastructure

11.1. NTP

11.1.1. NTP Overview

Network Time Protocol (NTP) provides accurate time across a whole network of devices such as routers or switches and synchronizes time among these devices on a network. NTP uses an NTP server that maintains a highly accurate time. An NTP network is comprised of devices (clients) that are to be synchronized with the NTP server that has UTC time and provides it to the client devices.

Prerequisites

- Install and configure an NTP server on your network and remember the IP address of the NTP server.

Supported Platforms

Not all features are necessarily supported on each hardware platform. Refer to the *Platform Guide* for the features and the sub-features that are or are not supported by each platform.

11.1.2. NTP Configuration

Configuration Syntax and Commands

The following sections describe the NTP configuration syntax and commands.

Specifying the NTP Server

To configure the NTP server, you must specify details such as the IPv4 address and the domain name of the NTP server.

Syntax

set system ntp server <server-id> <option>

Attribute	Description
server <server-id>	Specifies the name of the NTP server.
ipv4-address <ipv4-address>	Specifies the IPv4 address of the NTP server.
domain-name <domain-name>	Specifies the domain name of the NTP server.
minpoll	Specifies the minimum interval between requests in seconds. NTP dynamically selects the optimal poll interval between the values specified for minpoll and maxpoll.
maxpoll	Specifies the maximum interval between requests in seconds. NTP dynamically selects the optimal poll interval between the values specified for minpoll and maxpoll.

Example:

```
{
  "ietf-restconf:data": {
    "rtbrick-config:system": {
      "ntp": {
        "server": [
          {
            "server-name": "NtpServerIPv4",
            "ipv4-address": "192.168.16.1",
            "minpoll": 3,
            "maxpoll": 17
          }
        ]
      }
    }
  }
}
```

NTP Service Configuration

You can enable the NTP service under a specific VRF where NTP server is reachable (usually, the inband management VRF).

Syntax:

set inband-management instance <name> **ntp**

Attribute	Description
<name> <instance-name>	Name of the instance
true/false	Enable or disable Network Time Protocol.

Example: NTP Configuration

```
{
    "rtbrick-config:inband-management": {
      "instance": [
        {
          "name": "mgmt-vrf",
          "ntp": "true"
        }
      ]
    }
  }
```

Setting the System Date & Time Using DHCP Option 42 NTP Servers Information

The RtBrick RtBrick Host installer image performs a boot time ntpdate operation to set the system date and time.

By default, it uses the pool.ntp.org but DHCP bindings received over the ma1 interface will override it if DHCP option 42 contains a list of one or more NTP servers.

Separately from this boot time setting, the system will continue to use NTPd to maintain accurate system date and time using the list of NTP servers contained in the RBFS configuration.

The /etc/ntp.boot-time-servers.conf file can be used to verify as its contents will be updated with the NTP servers from DHCP. Also, logs are available in /var/log/rtbrick-boot-time-ntpdate.log.

Enabling RBFS Logs to Monitor NTP Peer Events

You can enable RBFS logs to monitor NTP peer events, allowing RBFS to fetch peer statistics using NTP Mode 6 control messages. Additionally, the "show" commands have been improved to offer information on NTP status, associations, history, and more detailed insights.

The configuration below enables RBFS logs for NTP peer events. It sets the log module to "resmon," specifies the group as "resmon-ntp-peer-events," sets the log level to "info," and sets the rate limit to "0."

```
set log module resmon
set log module resmon group resmon-ntp-peer-events
set log module resmon group resmon-ntp-peer-events level info
set log module resmon group resmon-ntp-peer-events rate-limit 0
```

11.1.3. NTP Operational Commands

OSPF Show Commands

NTP Status

Displays the NTP status information.

Syntax:

show ntp status

```
supervisor@rtbrick>LEAF01: cfg> show ntp status
associd=0 status=0615 leap_none, sync_ntp, 1 event, clock_sync,
version="ntpd 4.2.8p12@1.3728-o (1)", processor="x86_64",
system="Linux/5.4.40-OpenNetworkLinux", leap=0, stratum=3,
precision=-23, rootdelay=8.000, rootdisp=22.954, refid=198.51.100.13,
reftime=0xebe02d40.3a7421ac  2025-05-27T12:23:28.228334+00:00,
clock=0xebe03159.0c75c3b2  2025-05-27T12:40:57.048671+00:00,peer=60555,
tc=9, mintc=3, offset=-0.167277, frequency=-8.965, sys_jitter=0.076656,
clk_jitter=0.105, clk_wander=0.019
```

NTP Peer

Displays history of the NTP peers, showing when they went up or down and any changes in their status, identified by the peer’s IP address.

Syntax:

show ntp peer <options>

Option	Description
<peer-ip>	IP address of the NTP peer to show history for.
history	Displays history of the NTP peers, showing when they went up or down and any changes in their status, identified by the peer's IP address.
detail	Displays detailed information for a specific NTP peer, including its association ID, status, source address, port, hostname, destination address, leap indicator, stratum, precision, root delay, root dispersion, reference ID, reference time, receive time, reachability, host mode, peer mode, poll intervals, headway, key ID, offset, delay, dispersion, and jitter.
<peer-ip> history	Displays the history of a specific NTP peer.
<peer-ip> detail	Displays detailed information for a specific NTP peer.

The example below shows the history of a specific NTP peer, showing when it went up or down and any changes in its status.

```
supervisor@rtbrick>LEAF01: cfg> show ntp peer 198.51.100.13 history
srcadr               timestamp                                 associd     status    reason
198.51.100.13        Tue May 27 10:15:27 GMT +0000 2025          60555       1414    Peer Up
198.51.100.13        Tue May 27 12:24:52 GMT +0000 2025          60555       161a    Selected as Best
```

The example below shows detailed information of the NTP peers using NTP Mode 6 control message READVAR, including their association ID, status, source address, port, hostname, destination address, leap indicator, stratum, precision, root delay, root dispersion, reference ID, reference time, receive time, reachability, host mode, peer mode, poll intervals, headway, key ID, offset, delay, dispersion, and jitter.

```
supervisor@rtbrick>LEAF01: cfg> show ntp peer detail
associd: 60555, status: 161a
  srcadr: 198.51.100.13, srcport: 123
  srchost: node-2.infogral.is
  dstadr: 198.51.100.101, Port: 123
  leap: 0 leap_none, stratum: 2, precision: -25
  rootdelay: 5.112
  rootdisp: 0.290
  refid: 192.0.2.4
  reftime: 2025-05-27T12:34:07.000003+0000
  rec: 2025-05-27T12:36:32.000003+0000
  reach: 336, unreach: 2
  hmode: 3 pmode: 4, hpoll: 9, ppoll: 9
```

```
  headway: 0, keyid: 0
  flash: 0 Ok
  offset: -0.198
  delay: 2.828
  dispersion: 16.124001
  jitter: 0.638
  xleave: 0.036000
<...>
```

NTP Associations

Displays the information about the various NTP servers configured.

Syntax:

show ntp association <options>

Option	Description
no-resolve	Details without DNS resolution.

```
supervisor@rtbrick.net: op> show ntp association
Flags: * Synchronized, # Almost synchronized, + Selected for possible synchronization,"
       – Candidate for selection, ~ Statically configured"
Remote              Refid            St  T  When  Poll  Reach    Delay   Offset   Jitter
+194.50.19.117      131.188.3.222     2  u   522  1024    377    4.939    0.162    0.069
*193.203.3.171      .GPS.             1  u   897  1024    377    9.791    0.008    0.066
-51.75.67.47        157.13.205.54     3  u   770  1024    377    4.929   -0.110    0.149
+85.215.189.120     192.53.103.103    2  u   868  1024    377   13.483    0.043    0.181
-167.235.70.245     195.176.26.205    2  u   757  1024    377    0.883    0.158    0.332
-162.159.200.123    10.163.8.4        3  u   642  1024    377    4.160    0.439    0.484
```

System Uptime

The show system uptime command provides a timeline summary of the system, including when it booted, when forwarding started, last configuration change, and current CPU load.

Syntax:

show system uptime

Example for the command:

```
supervisor@rtbrick.net: cfg> show system uptime
Time source: NTP CLOCK, Current time: 2026-04-02 04:46:30 UTC
Forwarding started: 2026-04-01 11:48:23 UTC (16 hours, 58 minutes ago)
Last configured: 2026-04-02 04:45:08 UTC (1 minute ago) by supervisor
Container boot time: 2026-04-01 11:08:55 UTC (17 hours, 37 minutes ago)
CPU load averages [1m, 5m, 15m]: 1.58, 1.56, 3.32
```

Verifying NTP Service on Linux

To get more information about NTP's status, use the ntpq command:

The command displays the NTP servers that the system is synchronized with.

```
supervisor@rtbrick>LEAF01:~ $ sudo ntpq -p
     remote           refid      st t when poll reach   delay   offset  jitter
==============================================================================
198.51.100.5       .XFAC.          16 u    -   64    0    0.000    0.000   0.000
```

11.2. Clock Synchronization

11.2.1. Clock Synchronization

Overview

Overview

This guide provides an overview of high-precision clock synchronization mechanisms, including the Precision Time Protocol (PTP), a protocol for clock synchronization supported in RBFS, and covers its configuration and operational commands. PTP is used to synchronize clocks across a network with high precision, achieving accuracy in the nanosecond range.

PTP synchronizes clocks by exchanging timestamped messages between devices. The slave device calculates the clock offset and network delay, then continuously adjusts its clock using a servo algorithm for smooth and precise synchronization. A Hardware Clock (PHC) ensures nanosecond precision for timestamps.

The diagram below illustrates how the **master clock** serves as the reference time source, and the **slave clocks** (Switch-1 and Switch-2) synchronize their time to that of the master.

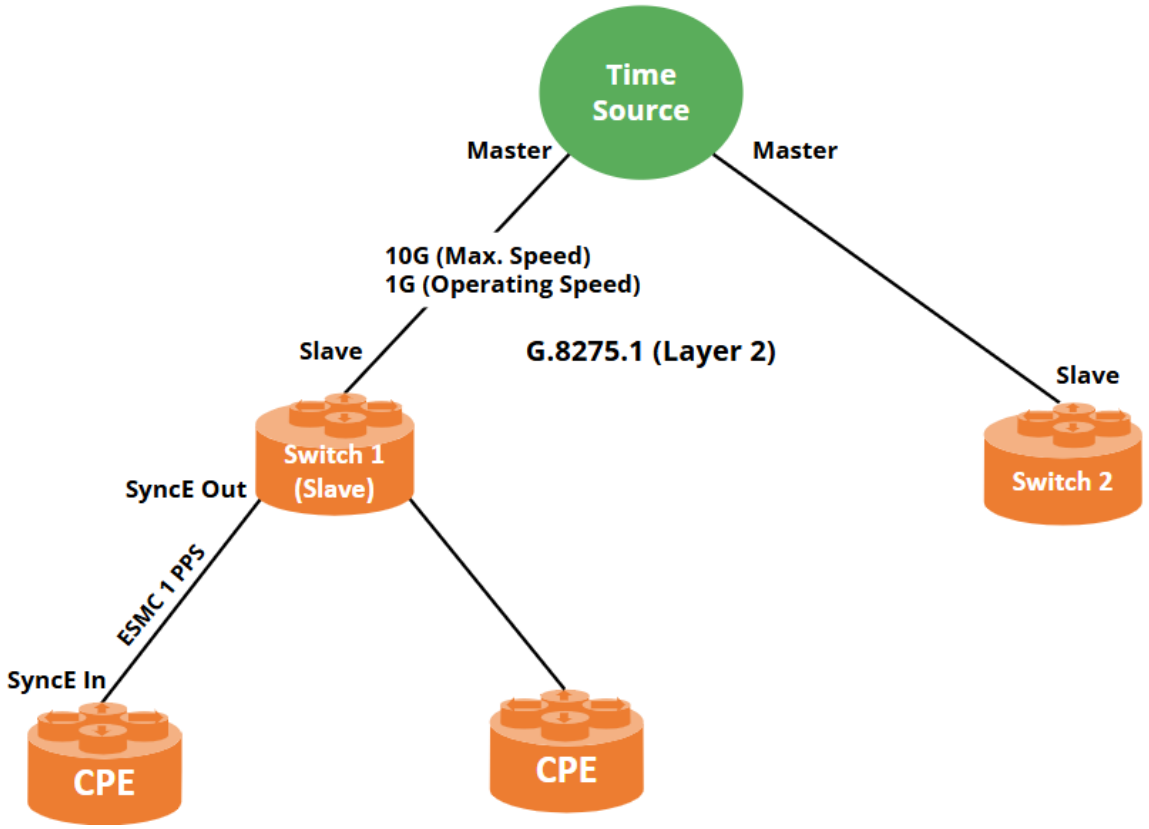


Figure 161. Clock Synchronization Overview

RBFS supports the following PTP profiles and standards:

- IEEE 1588-2008: Describes the IEEE 1588-2008 standard for Precision Time Protocol (PTP) used in clock synchronization.
- ITU-T G.8275.1: Defines the timing requirements for packet-based networks to support time-sensitive applications.

In addition, RBFS supports PTP operation at Layer 2.

SyncE ESMC Support

SyncE (Synchronous Ethernet) and ESMC (Ethernet Synchronization Messaging Channel) are crucial components for precise time synchronization in networks.

SyncE provides a mechanism for distributing frequency synchronization over Ethernet at the physical layer (Layer 1). It ensures that all connected network elements operate on the same clock frequency, preventing clock drifts and maintaining a stable timing reference.

ESMC is a Layer 2 protocol (EtherType: 0x8809) that complements SyncE by carrying Synchronization Status Messages (SSMs). These messages convey

information about the quality of the clock source being used by SyncE. ESMC allows network devices to select the best available clock source and to automatically switch to a different, higher-quality source if the current one degrades or fails.

Licensing Requirements

Clock synchronization requires a separate license to be procured from RtBrick, in addition to other licenses.

Supported Platforms

Not all features are supported on every hardware platform. Refer to the undefined/techdocs/current/platform/feature_support_matrix.html[Feature Support Matrix] section of the *Platform Guide* for details about which features and sub-features are supported on each platform.

11.2.2. Clock Synchronization Configuration

Clock Synchronization configuration involves global and interface-level settings.

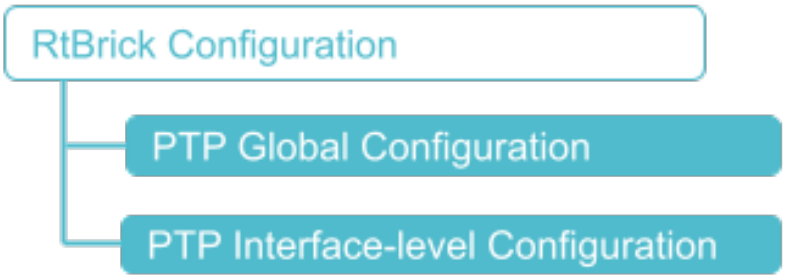


Figure 162. Clock Synchronization Configuration Hierarchy

Global Configuration

These commands configure the global clock Synchronization settings for the system.

Syntax:

```
set system ptp clock <options>
```

Attribute Description:

Attribute	Description
clock g8275.1	Enables ITU-T G.8275.1 clock profile for PTP.  As per ITU-T G.8275.1 profile, the default domain value for the PTP is 24.
clock g8275.1 mode (slave | boundary)	Configures the PTP clock to operate in slave or boundary mode. **slave**: The device synchronizes its local clock to an upstream master. **boundary**:The device acts as both a slave (upstream) and a master (downstream), relaying and conditioning timing information.

The example below shows the configuration for enabling PTP (Precision Time Protocol) in slave mode using the g8275.1 profile.

```
set system ptp clock g8275.1 mode slave
```

```
supervisor@rtbrick.net: cfg> show config system ptp
{
  "rtbrick-config:ptp": {
    "clock": [
      {
        "profile": "g8275.1",
        "mode": "slave"
      }
    ]
  }
}
```

The example below shows the configuration for enabling PTP (Precision Time Protocol) in boundary mode using the g8275.1 profile.

```
set system ptp clock g8275.1 mode boundary
```

```
supervisor@rtbrick.net: cfg> show config system ptp
{
  "rtbrick-config:ptp": {
```

```
    "clock": [
      {
        "profile": "g8275.1",
        "mode": "boundary"
      }
    ]
  }
}
```

Interface-level Configuration

These commands enable and configure PTP on specific network interfaces.

Syntax:

set interface <interface-name> <attribute> <value>

Attribute	Description
<interface-name>	Name of the network interface.
ptp enable true	Enables (true) clock synchronization for the specified interface
synce enable true	Enables (true) synchronous Ethernet for the specified interface
synce esmc true	Enables (true) ESMC (Ethernet Synchronization Message Channel) for the specified interface

After the clock module is enabled and the clock is configured on the device, you can enable ptp, synce, and synce esmc on the network interface.

The following configuration enables PTP on the network interface named "ifp-0/1/66".

```
set interface ifp-0/1/66
set interface ifp-0/1/66 ptp enable true
```

```
supervisor@rtbrick.net: cfg> show config interface ifp-0/1/66
{
  "rtbrick-config:interface": [
    {
      "name": "ifp-0/1/66",
      "ptp": {
        "enable": "true"
      }
```

```
    }
  ]
}
```

The following configuration enables synce on the network interface named "ifp-0/1/66".

```
set interface ifp-0/1/66
set interface ifp-0/1/66 sync enable true
```

```
supervisor@rtbrick.net: cfg> show config interface ifp-0/1/66
{
  "rtbrick-config:interface": [
    {
      "name": "ifp-0/1/66",
      "sync": {
        "enable": "true"
      }
    }
  ]
}
```

The following configuration enables synce esmc on the network interface named "ifp-0/1/66".

```
set interface ifp-0/1/66
set interface ifp-0/1/66 sync synce esmc true
```

```
supervisor@rtbrick.net: cfg> show config interface ifp-0/1/66
{
  "rtbrick-config:interface": [
    {
      "name": "ifp-0/1/66",
      "sync": {
        "esmc": "true"
      }
    }
  ]
}
```

PTP and SyncE ESMC Destination MAC Configuration

You can configure the destination MAC for outgoing SyncE ESMC and PTP packets. The following CLI commands allow you to configure the destination MAC address for SyncE ESMC packets.

Syntax:

set system synce esmc destination-mac-address <destination-mac-address>

set system ptp global destination-mac-address <destination-mac-address>

Attribute	Description
<destination-mac-address>	Specifies the destination MAC address for outgoing SyncE and PTP packets.  If no destination MAC address is configured, the system will use the default MAC address.

The following example sets the destination MAC address for SyncE ESMC packets to 01:80:C2:00:00:02.

```
set system synce esmc destination-mac-address 01:80:C2:00:00:02
```

```
{
  "rtbrick-config:system": {
    "synce": {
      "esmc": {
        "destination-mac-address": "01:80:C2:00:00:02"
      }
    }
  }
}
```

The following example sets the destination MAC address for PTP packets to 01:1B:19:00:00:00.

```
set system ptp global destination-mac-address 01:1B:19:00:00:00
```

```
{
  "rtbrick-config:system": {
    "ptp": {
      "global": {
        "destination-mac-address": "01:1B:19:00:00:00"
      }
    }
  }
```

```
}
```

11.2.3. Clock Synchronization Operational Commands

Validating the Configurations Using the ufi-ptp-cli Shell

To validate the configuration, use the ufi-ptp-cli shell as shown in the following example.

The following example displays the output of the show ptp clock info command, detailing the PTP clock's configuration. It includes information such as the clock identity, profile type (G.8275.1), clock type (Time Slave Clock), and various PTP interval settings.

```
supervisor@rtbrick>rtbrick.net:~ $ ufi-ptp-cli
Check UFI PTP Service Status ... Ready.
Read configuration successfully
Build On Jun 3 2025 02:14:45
ufi-ptp> enable
ufi-ptp# show ptp clock info
Clock Identity                  : 5C:07:58:A2:CE:5C:00:01
Profile                         : G.8275.1 profile
Clock Type                      : Time Slave Clock
Servo Alg                       : Full-On-Path
Number Of Ports                 : 32
Clock Class                     : 255
Domain Number                   : 24
Scaled Log Variance             : 0xFFFF
Priority1                       : 128
Priority2                       : 255
Slave Only                      : True
Two Step                        : False
Announce Receipt Timeout (min)  : 3
Announce Receipt Timeout (def)  : 3
Announce Receipt Timeout (max)  : 10
Log Announce Interval (min)     : -3
Log Announce Interval (def)     : -3
Log Announce Interval (max)     : -3
Log Sync Interval (min)         : -4
Log Sync Interval (def)         : -4
Log Sync Interval (max)         : -4
Log Min Delay Req Interval (min) : -4
Log Min Delay Req Interval (def) : -4
Log Min Delay Req Interval (max) : -4
Domain # (min)                  : 24
Domain # (def)                  : 24
Domain # (max)                  : 43
Priority 1                      : 128
Priority 2 (min)                : 0
Priority 2 (def)                : 128
Priority 2 (max)                : 225
Local Priority                  : 128
```

The following example displays the output of the show ptp port 67 peer command, detailing PTP packet statistics for peer 0 on Port 67. It provides counts of various received and transmitted PTP messages, such as Sync, Delay Request, Delay Response, and Announce messages.

```
ufi-ptp# show ptp port 9 peer
Port 9:
  Peer #0
  L2 address                      : D8:3A:DD:AA:4D:9D
  Clock Identity                  : D8:3A:00:FF:FE:AA:4D:9D
  Received Sync                   : 138913
  Received Delay Request          : 0
  Received Delay Response         : 138904
  Received Peer Delay Request     : 0
  Received Peer Delay Response    : 0
  Received Followup               : 138913
  Received Peer Delay Followup    : 0
  Received Announce               : 69457
  Received Signalling             : 0
  Received Management             : 0
  Transmitted Sync                : 0
  Transmitted Delay Request       : 138904
  Transmitted Delay Response      : 0
  Transmitted Peer Delay Request  : 0
  Transmitted Peer Delay Response : 0
  Transmitted Followup            : 0
  Transmitted Peer Delay Followup : 0
  Transmitted Announce            : 0
  Transmitted Signalling          : 0
  Transmitted Management          : 0
```

The show ptp port 67 master command output displays that port 67 has one PTP master identified as E1:C1:1A:G5:L2:15.

```
ufi-ptp# show ptp port 67 master
Port 67:
Master #0 : E1:C1:1A:G5:L2:15
ufi-ptp#
```

PTP Show CLIs

show ptp clock-info

This command displays detailed information about the PTP clock running on the device.

Syntax:

show ptp clock-info

The following example displays detailed information about the PTP clock. Key details include the clock identifier, profile (g8275.1), clock type (Slave Clock), domain number, and various PTP interval settings.

```
supervisor@rtbrick>switch: op> show ptp clock-info
Clock Information
  Clock identifier: 5c:07:58:a2:ce:5c:00:01
  Profile: g8275.1
  Clock type: Slave Clock
  Max number of ports: 32
  Clock class: 255
  Domain number: 24
  Scaled log variance: 0xFFFF
  Priority1: 128
  Priority2: 255
  Slave only: True
  Announce receipt timeout (Min): 3
  Announce receipt timeout (Def): 3
  Announce receipt timeout (Max): 10
  Log announce interval (Min): -3
  Log announce interval (Def): -3
  Log announce interval (Max): -3
  Log sync interval (Min): -4
  Log sync interval (Def): -4
  Log sync interval (Max): -4
  Log delay req interval (Min): -4
  Log delay req interval (Def): -4
  Log delay req interval (Max): -4
  Domain min: 24
  Domain default: 24
  Domain max: 43
  Priority2 min: 0
  Priority2 default: 128
  Priority2 max: 225
  Local priority: 128
  PTP Timescale: False
Current Status
  Offset from master: 543021312.000000
  Mean path delay: -98.000000
  Steps removed: 2
Time Properties
  Current UTC offset: 0
  Current UTC offset valid: True
  Leap 59: False
  Leap 61: False
  Parent clock accuracy: 0x20
  Time traceable: True
  Frequency traceable: True
  Time source: GPS
  Time of day: Fri Dec 12 2025 11:03:38.062676 UTC
```

show ptp peer

This command displays detailed information about the PTP peers discovered on the interface ifp-0/1/61.

Syntax:

show ptp peer <interface>

Option	Description
-	Without any option, the commands displays the PTP peer information for all interfaces.
<interface>	Displays the PTP peer information for the specified interface.

The following example displays the output of the show ptp peer command for interface ifp-0/1/8. It details information about a PTP peer, including its address, clock ID, port state (Uncalibrated), and counts of various PTP messages received and transmitted.

```
supervisor@rtbrick>ufi16.q2c.u13.r5.nbg.rtbrick.net: cfg> show ptp peer
ifp-0/1/8
 Peer address: d8:3a:dd:aa:4d:9d
 Clock id: d8:3a:00:ff:fe:aa:4d:9d
 Mode: 0
 Port state: Uncalibrated
 Mean path delay: 685
 Log announce interval: -3
 Log sync interval: -4
 Log delay req interval: -4
 Rx sync: 163344
 Rx delay req: 0
 Rx delay resp: 163336
 Rx follow up: 163344
 Rx pdelay follow up: 0
 Rx announce: 81672
 Rx signalling: 0
 Rx management: 0
 Tx sync: 0
 Tx delay req: 163336
 Tx delay resp: 0
 Tx follow up: 0
 Tx pdelay follow up: 0
 Tx announce: 0
 Tx signalling: 0
 Tx management: 0
```

The following example displays the output of the show ptp peer interface ifp-0/1/8 command, providing details about a PTP peer on interface ifp-0/1/8. It includes the peer's address and clock ID, its "Uncalibrated" port state, and various counts of PTP messages received and transmitted.

```
supervisor@rtbrick>switch: op> show ptp peer interface ifp-0/1/8
ifp-0/1/8
  Peer address: d8:3a:dd:aa:4d:9d
  Clock id: d8:3a:00:ff:fe:aa:4d:9d
  Port state: Uncalibrated
  Mean path delay: 685
  Mode: 0
  Log announce interval: -3
  Log sync interval: -4
  Log delay req interval: -4
  Rx sync: 163344
  Rx delay req: 0
  Rx delay resp: 163336
  Rx follow up: 163344
  Rx pdelay follow up: 0
  Rx announce: 81672
  Rx signalling: 0
  Rx management: 0
  Tx sync: 0
  Tx delay req: 163336
  Tx delay resp: 0
  Tx follow up: 0
  Tx pdelay follow up: 0
  Tx announce: 0
  Tx signalling: 0
  Tx management: 0
```

show ptp servo

This command displays the status and configuration of the PTP servo mechanism on a device. The servo is a critical component in PTP that adjusts the local clock to synchronize with a master clock.

Syntax:

```
show ptp servo
```

The following example displays the output of the show ptp servo command, providing the PTP servo statistics for Clock 0. It details the servo's configuration, current state ("Frequency Locked"), lock status ("Locked"), and various correction and packet rate values.

```
supervisor@rtbrick>switch: op> show ptp servo
Servo Stat for Clock 0
  Servo config: Freq + Phase Correction
  Servo state: Frequency Locked
  Servo state duration: 2:49:37
  Lock status: Locked
  APTS mode: N/A
  Frequency correction: 12000.000000 ppb
  Phase correction: 542500000.000000 nsec
  Offset from master: -542543518.000000 nsec
  Mean path delay: 458.000000 nsec
  APTS GPS to PTP offset: N/A
  Sync packet rate: 16
  Delay packet rate: 16
```

show ptp statistics

This command displays the PTP packet statistics for a device.

Syntax:

show ptp statistics <interface>

Option	Description
-	Without any option, the commands displays the PTP packet statistics for all interfaces.
<interface>	Displays the PTP packet statistics for the specified interface.

The following example displays the output of the show ptp statistics command, detailing both global and interface-specific (ifp-0/1/8) PTP packet transmission, reception, and discard counts.

```
supervisor@rtbrick>switch: op> show ptp statistics
Total PTP statistics
  Tx: 161895   Rx: 566652   Discarded: 16
Interface           Tx             Rx             Discarded
ifp-0/1/8           161895         566652         16
```

The following example displays PTP packet statistics for interface ifp-0/1/8, showing 161895 packets transmitted, 566652 received, and 16 discarded.

```
supervisor@rtbrick>switch: op> show ptp statistics interface ifp-0/1/8
ifp-0/1/8
```

```
  Tx: 161895
  Rx: 566652
  Discarded: 16
```

SyncE ESMC Show CLIs

show synce statistics

This command displays the SyncE statistics.

Syntax:

show synce statistics <interface>

Option	Description
-	Without any option, the commands displays the SyncE statistics for all interfaces.
<interface>	Displays the SyncE statistics for the specified interface.

The following example displays the output of the show synce statistics command for all interfaces.

```
supervisor@rtbrick>switch: op> show synce statistics
ifp-0/1/20
    ESMC Rx: 0
    ESMC Tx: 10719
    Total: 10719
ifp-0/1/69
    ESMC Rx: 0
    ESMC Tx: 30
    Total: 30
```

The following example displays SyncE statistics for the interface ifp-0/1/20.

```
supervisor@rtbrick>switch: op> show synce statistics interface ifp-0/1/20
ifp-0/1/20
    ESMC Rx: 0
    ESMC Tx: 10269
    Total: 10269
```

11.3. Logging

11.3.1. Logging Overview

RBFS logging is the process of writing log messages during the execution of events. RBFS logging provides reports on events across the entire RBFS ecosystem, spanning different functional areas. In a hardware switch, this happens at 2 levels:

- Inside the RBFS container
- In the RtBrick Host

All these logs, generated by different components, can be exported to the log management server, where you can view and analyze real-time data.

RBFS provides logging for the entire RBFS ecosystem, including Brick Daemons (BD), as well as other (non-BD) daemons. Brick Daemons are built on top of Brick Data Store (BDS), and other (non-BD) daemons (such as Prometheus) are the ones that are not dependent on BDS. BDS provides an in-built infrastructure for logging, which can be used by all BDS applications.

The diagram below shows how logs generated within the RBFS container (from Brick Daemon, Prometheus, and Syslog) and from API Gateway Daemon (APIGWD) are sent to Controller Daemon (CTRLD) on the RtBrick host. CTRLD aggregates these logs and exports them to an external Log Management Server for centralized monitoring and analysis.

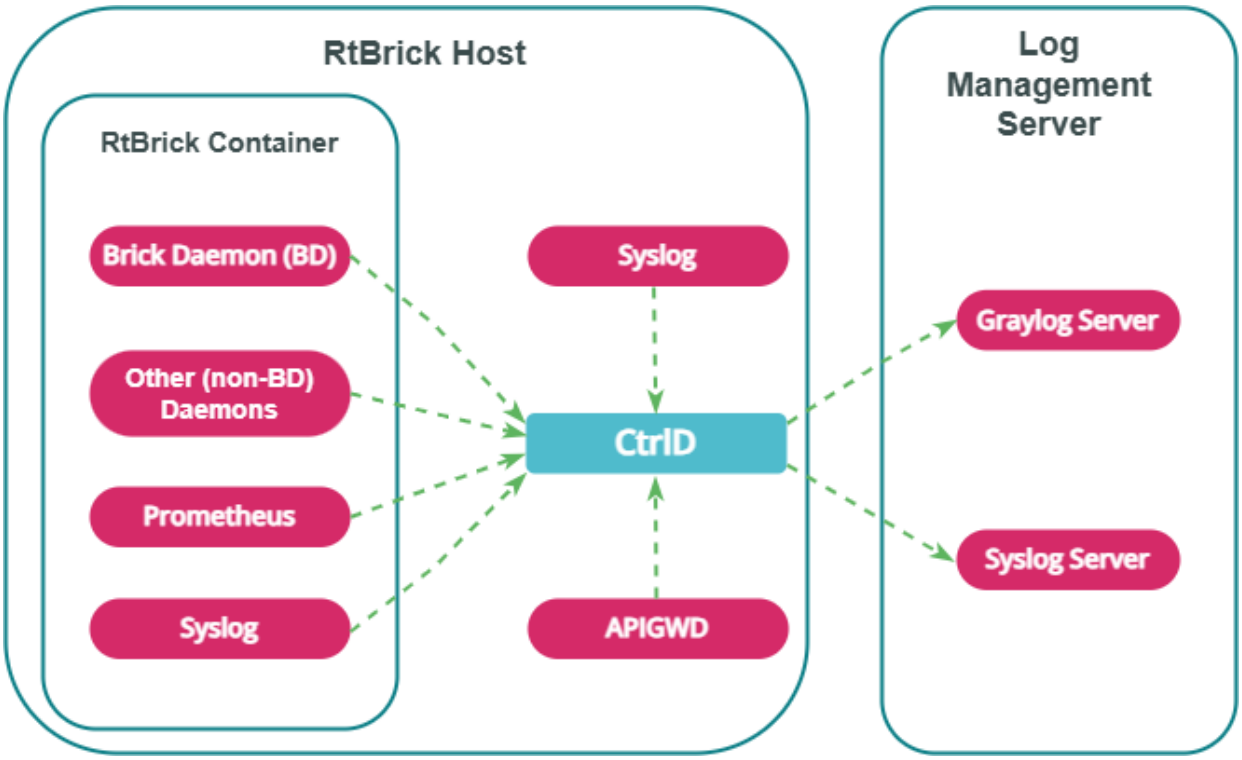


Figure 163. Logging Overview

Logging in RBFS Container

The RBFS container logging infrastructure (BDS Logging) provides low-latency, in-memory logging for large-scale systems without significant performance impact.

BDS Logging

Log Tables

BDS logs are stored in a BDS table. BDS creates a log table for each module in a BD. One entry is added to this log table for every log. Older entries are removed from the table when the number of entries exceeds 10,000. A log table is created for a module only if that module has at least one logged event. Every module in RBFS has at least one log table named in this format: **<modulename>.<bd-name>.log**.

Log Maps

Each log is mapped to a single event logged by the application. To optimize memory usage, RBFS does not store verbose strings; instead, it stores the log map as an identifier to the actual string message.



The log map and the log ID refer to the same entity.

Log Modules

Every BDS application consists of multiple modules. Logging can be configured for each BDS module separately.

The log modules supported by RBFS are: access_service, bcm_q2c, bd, bds, bds_mock, bgp, fib, fwdinfra, hostconfd, ifm, igmp, ipoe, isis, l2tp, lag, ldp, license, lldp, lwip_contrib, mrib, nat, oam, ospf, pim, policy, pool, poold, pppoe, pubsub, resmon, rib, rtbrick-cli, secure_management, snapshot, static, subsMgmt, time_series, validation, vpp.

Log Groups

A log group is a collection of log maps or log IDs. Groups have been introduced to simplify the log configuration tasks. For example, to debug a BGP peer issue, instead of enabling the entire bgp module logs, you can enable logging for the BGP peer log group.

Guidelines and Limitations for BDS Logging

The following are some guidelines and limitations for BDS logging:

- By default, BDS logging is enabled, and the log level is set to 'Error'.
- By default, logging for the BDS and PUBSUB modules has been disabled.
- The user can configure log levels per BD or per module.
- In a scaled setup, logging should not be kept enabled for an extended period.
- When you set the log-level to "None", the log is disabled for the specific module, group, or globally.

Non-BDS Logging

Syslog

Syslog is generated by the Linux API-based logging mechanism. RBFS Linux container uses syslog for logging. Syslog can also be exported to Graylog. Currently, RBFS supports exporting syslog messages from the Linux system facilities, such as auth, authpriv, daemon, and kern, to Graylog.

TSDB (Prometheus) Alert Messages

Prometheus is the system and service monitoring application that can be deployed in RBFS to collect and process metrics. In RBFS, Prometheus-generated alert messages are forwarded to CtrlD, and from there they can be exported to the configured log management servers.

Logging in to the RtBrick Host

In RBFS, there are daemons that are not part of the RBFS container but run on the RtBrick host. RBFS provides logging for these daemons.

CTRLD

CtrlD logging provides log messages of events related to elements, ZTP, and security.

APIGWD

ApiGwD logs contain details about who accessed the API and how they accessed it.

Plugin Alias

Any logs in RBFS can be exported to an external logging destination. Currently, CtrlD supports GELF and syslog as external plugins.

CtrlD is the egress node for all the GELF (Graylog Extended Log Format) messages. The brick daemons are configured to send GELF messages to CtrlD, which forwards them to the configured endpoints, such as syslog or a GELF endpoint. This is because CtrlD enhances the GELF message with switch-global settings (such as the switch's serial number).

Supported Logging Formats

RBFS supports two types of logging formats: GELF and Syslog.

GELF

GELF is a logging format for Graylog. It uses JSON to structure log messages, making them searchable and more structured. The supported protocol for GELF is HTTP.

The diagram below shows the example of a GELF message on the Graylog Web Interface.

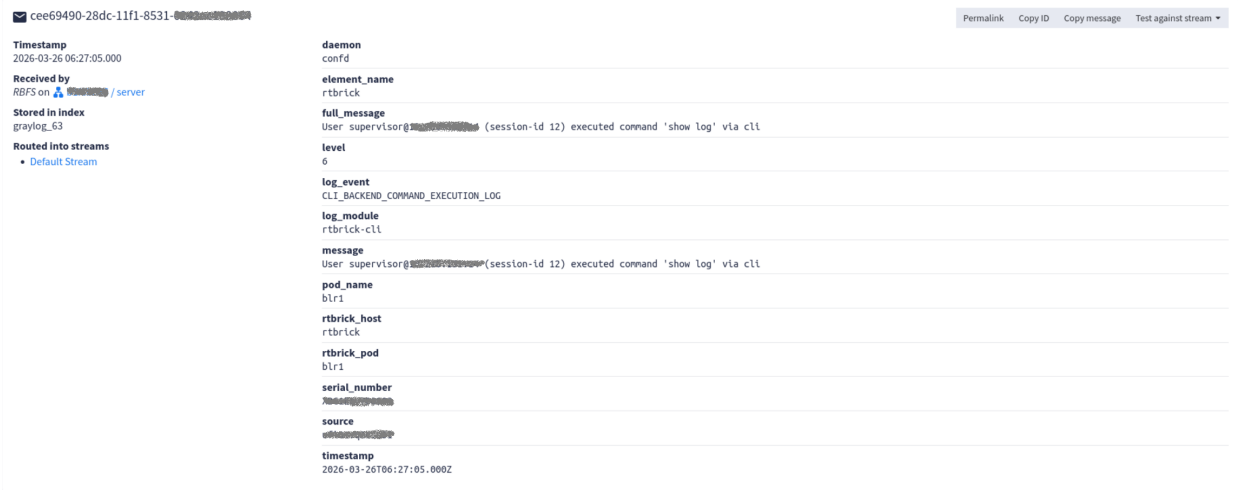


Figure 164. GELF Message Shown on the Graylog Web Interface

Syslog

Syslog is a format used by Linux systems and many networking devices for logging. It is a plain text protocol with a defined structure. The supported Syslog transport protocols are TCP and UDP.

The diagram below shows the example of a message in syslog format as displayed on the Graylog Web Interface.

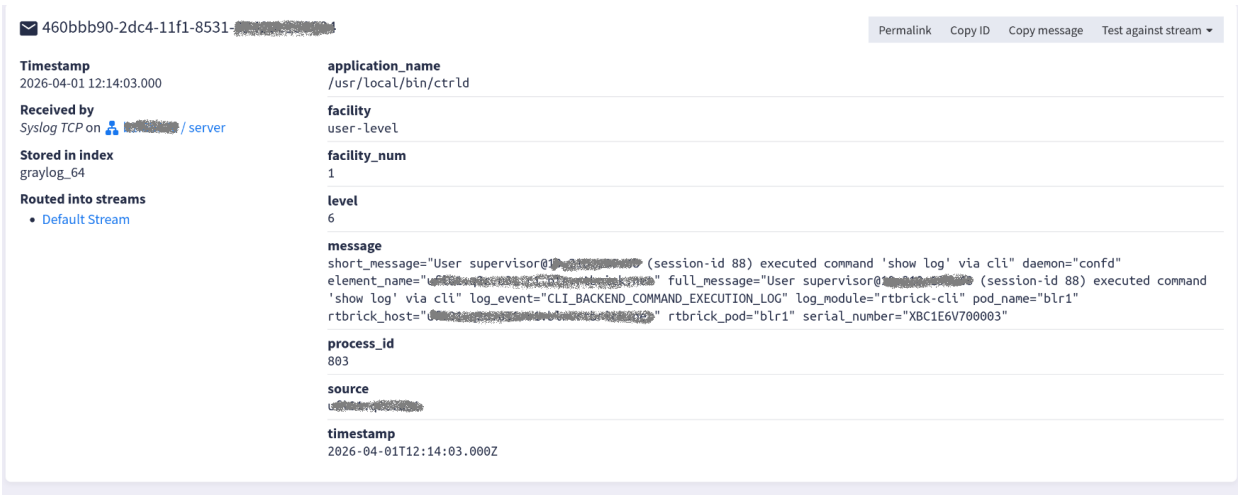


Figure 165. Syslog Message Format Shown on the Graylog Web Interface

Log Levels

Log level indicates the severity of events (logs). You can configure logging by severity level. The diagram below shows the log levels supported by RBFS in order of priority:

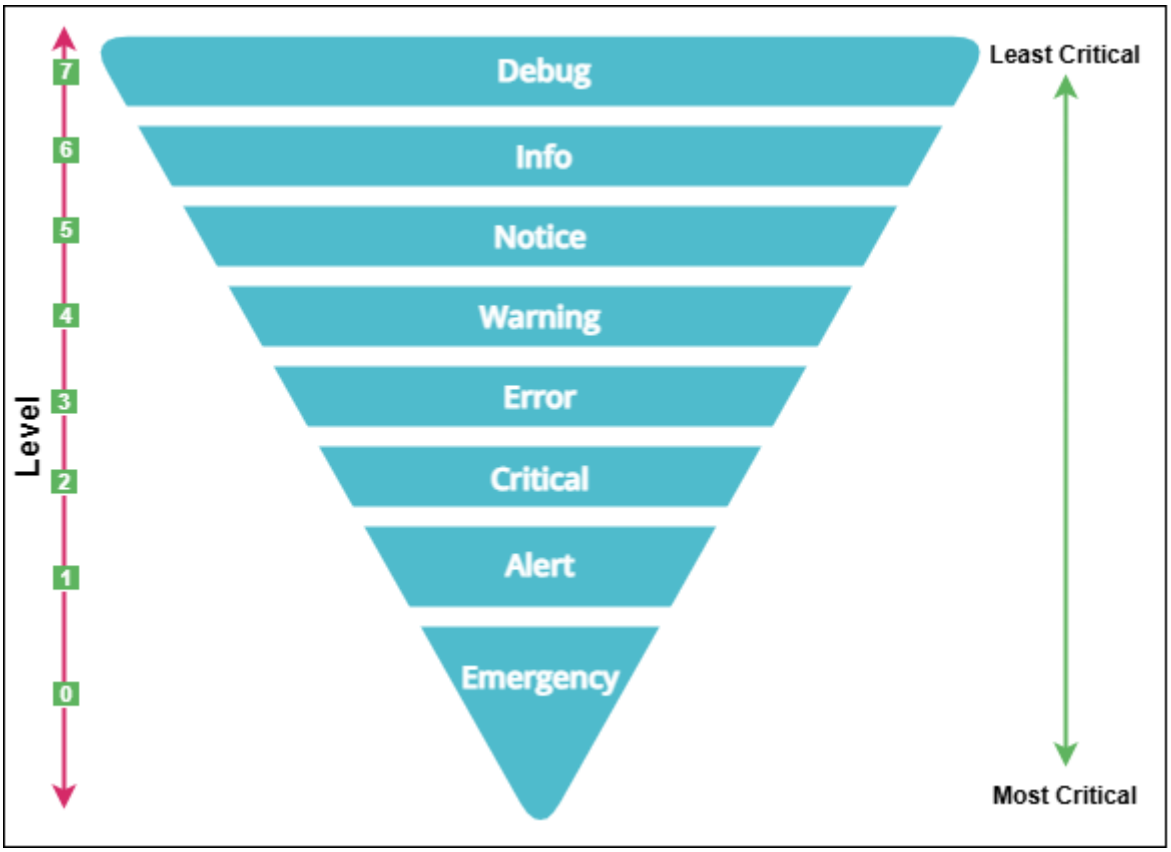


Figure 166. Log Levels

Level	Level Name	Description
0	Emergency	Events that cause the application to terminate.
1	Alert	A condition that should be corrected immediately. For example, “ISIS_AUTHENTICATION_FAIL” indicates an IS-IS authentication failure.
2	Critical	Severe error that will prevent the application from continuing. For example, “LICENSE_EXPIRY_CRITICAL” indicates that the current license has expired.
3	Error	Events that cause issues. For example, “LICENSE_EXPIRY_ERROR” indicates that the current license is about to expire.

Level	Level Name	Description
4	Warning	Events that might cause issues. For example, “LICENSE_EXPIRY_WARNING” indicates that the current license is about to expire.
5	Notice	Conditions that are not error conditions, but that may require special handling. For example, “PPPOE_SESSION_LIMIT_REACHED” indicates that the PPPoE session limit has been reached.
6	Info	Events showing normal application behaviour. For example, “PPPOE_SESSION_DELETE” indicates that the PPPoE session deletion has occurred.
7	Debug	Diagnostic information used for debugging. For example, “PPPOE_LCP_START_ECHO” indicates that the PPP LCP echo request interval has started.

- All log levels below the specified level are logged. For example, if the level is "Warning” (4), logs at levels such as "Error" (3), "Critical" (2), "Alert" (1), and "Emergency" (1) are included.
- Any level above “Warning” indicates that you should log with caution, as they may cause system instability in a scaled environment.

Supported Platforms

Not all features are necessarily supported on each hardware platform. Refer to the Platform Guide for the features and sub-features supported by each platform.

11.3.2. Logging Configuration

Configuration Overview

You can enable logging for:

- Brick Daemon (such as pppod, ipod, confd)
- Modules (such as OSPF, BGP, IS-IS)
- RtBrick Host system

Configuration Hierarchy

The diagram illustrates the logging configuration hierarchy.

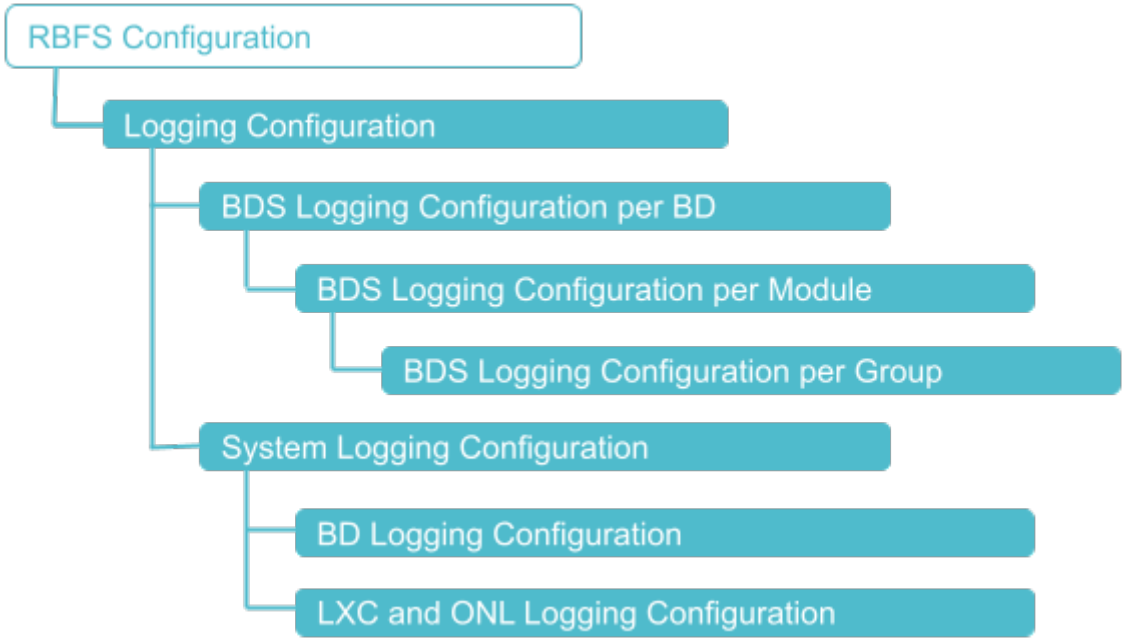


Figure 167. Logging Configuration Hierarchy

Configuration Syntax and Commands

The following sections describe the logging configuration syntax and commands.

BDS Logging Configuration

You can configure BDS logging for a BD, a module, and for a group.



A specific configuration takes priority over a generic configuration. For example, if you have configured a daemon log level of bgp.iod.1 to "warning", and you have configured a log level of BGP module to "notice", then the final log level of BGP will be "notice".

Configuring BDS Logging for a Brick Daemon

You can configure BDS logging for a brick daemon or all daemons to generate logs related that daemon/daemons.

Syntax:

set log bd <bd-name> <attribute> <value>

Attribute	Description
<bd-name>	Configure for the specified BD name.
all	Configure for all BDs.
module <module-name>	Module name. For more information, see the section "Configuring BDS Logging for a Module".
plugin-alias alias-name <alias-name>	Specify the external log management server name for sending the logs to the server.
plugin-alias level <level>	Log severity level. You can filter logs based on the log severity levels for sending to the external log management server. This allows to send only the required log messages to the log management server instead of sending a whole lot of data. For example, if you configure Warning as the severity level, logs with the severity level 'Warning' and all the log levels above Warning such as Error, Critical, Alert, and Emergency will be sent to the log management server.

The following example shows how to configure BDS logging for a brick daemon.

```
set log bd bgp.iod.1 level info
set log bd bgp.iod.1 plugin-alias alias-name ztp plugin-alias level error
```

```
{
  "ietf-restconf:data": {
    "rtbrick-config:system": {},
    "rtbrick-config:log": {
      "bd": [
        {
```

```
          "bd-name": "bgp.iod.1",
          "level": "info",
          "plugin-alias": {
            "alias-name": "ztp",
            "level": "error"
          }
        }
      ]
    }
  }
}
```

API To access the RESTCONF API that corresponds to this CLI, click here.

Configuring BDS Logging for a Module

You can enable logging for a module such as BGP, IS-IS.

Syntax:

set log module <module-name> <attribute> <value>

Attribute	Description
<module-name>	Module name
group <group-name>	BDS log module log-group configuration. For more information, see the section "Configuring BDS Logging for a Group".
level <level>	Log severity level.
plugin-alias alias-name <alias-name>	Plugin alias name

Attribute	Description
plugin-alias level <level>	Log level. You can filter logs based on the log severity levels for sending to the log management server. This will help you to send only the required log messages to the log management server instead of sending a whole lot of data. For example, if you configure Warning as the severity level, logs with the severity level 'Warning' and all the log levels above Warning such as Error, Critical, Alert, and Emergency will be sent to the log management server.

The following example shows how to configure BDS logging for a module.

```
set log module igmp level info
set log module igmp plugin-alias alias-name graylog-srv1 plugin-alias level
warning
```

```
{
  "ietf-restconf:data": {
    "rtbrick-config:system": {},
    "rtbrick-config:log": {
      "module": [
        {
          "module-name": "igmp",
          "level": "info",
          "plugin-alias": {
            "alias-name": "graylog-srv1",
            "level": "warning"
          }
        }
      ]
    }
  }
}
```

API To access the RESTCONF API that corresponds to this CLI, click here.

Configuring BDS Logging for a Group

You can enable logging for a group of log IDs. This configuration allows you to generate logs for a group of log IDs (also known as log maps). Using log groups, you can enable logging for a specific set of log IDs. This approach gives you more targeted control over log generation, helping you collect only the relevant

information without overwhelming the system.

Syntax:

set log module <module-name> **group** <group-name> <attribute> <value>

Attribute	Description
<group-name>	Group name
level <level>	Specifies the level of the plug-in alias.
rate-limit <rate-limit>	Rate-limiting is only supported for log groups. Configuring a higher rate-limit for a whole module may cause system instability due to generation of high volume of logs. The default value is 10.
plugin-alias alias-name <alias-name>	Plugin alias name
plugin-alias level <level>	Specifies the level of the plug-in alias. You can filter logs by severity level before sending them to the log management server. This will help you to send only the required log messages to the log management server instead of sending a whole lot of data. For example, if you configure Warning as the severity level, logs with the severity level 'Warning' and all the log levels above Warning such as, Error, Critical, Alert, and Emergency, will be sent to the log management server.

The following example shows how to configure BDS logging for a group.

```
set log module bgp group interface level warning
```

```
{
  "ietf-restconf:data": {
    "rtbrick-config:log": {
      "module": [
        {
          "module-name": "bgp",
          "group": [
            {
```

```
              "group-name": "interface",
              "level": "warning"
            }
          ]
        }
      ]
    }
  }
}
```

To access the RESTCONF API that corresponds to this CLI, click here.

System Logging (syslog) Configuration

LXC and RtBick Host Logging Configuration

In addition to configuring logging for the various daemons and modules in the RBFS container, you can also enable logging for the underlying RtBrick Host system. You can send logs from Linux and RtBrick Host system facilities, such as auth, authpriv, daemon, and kern to the log management server.

Also, you can configure an external log management server to transport logs. Currently, Syslog and Graylog are the log management servers supported by RBFS.

Syntax:

set log system facility <facility-name> **plugin-alias** <attribute> <value>

Attribute	Description
<facility-name>	Supported facilities include all, auth, authpriv, daemon, and kern.
plugin-alias alias-name <alias-name>	Plugin alias name

Attribute	Description
plugin-alias level <level>	Specify the level of the plug-in alias. You can filter logs based on the log severity levels for sending to the log management server. This will help you to send only the required log messages to the log management server instead of sending a whole lot of data. For example, if you configure Warning as the severity level, logs with the severity level 'Warning' and all the log levels above Warning such as, Error, Critical, Alert, and Emergency, will be sent to the log management server.

The following example shows how to configure system logging for the kern facility and send the logs to Graylog.

```
set log system facility kern plugin-alias alias-name graylog plugin-alias level
notice
```

```
{
  "ietf-restconf:data": {
    "rtbrick-config:log": {
      "system": {
        "facility": [
          {
            "facility-name": "kern",
            "plugin-alias": {
              "alias-name": "graylog",
              "level": "notice"
            }
          }
        ]
      }
    }
  }
}
```

API To access the RESTCONF API that corresponds to this CLI, click here.

Configuring an External Log Server (Plugin Alias)

You can configure an external log management server as a destination to send logs. This is done by configuring a plugin alias in RBFS. A plugin alias represents the log management server endpoint to which the logs will be sent. When you

configure a plugin alias, you specify the log management server details such as the address, type (Syslog or Graylog), network protocol (TCP or UDP), and severity level of the logs to be sent.



By default, logs are sent to the log management server through the device management interface (eth0 in hardware devices), which is intended for out-of-band management. If you want to send logs through an in-band connection, you need to enable in-band management on RBFS. For more information, see the section Configuring an External Log Server (Plugin Alias) Using In-band Connection

Syntax:

set system host log-alias <attribute> <value>

Attribute	Description
<name>	Log alias name
<address>	Plugin address. For example: GELF: http://192.0.2.0:1102/gelf Syslog: 198.51.100.0:525
level	Severity level for the log.
network	Log alias endpoint port.
type	Server type of log alias.

The following example shows how to configure a plugin alias for a log management server.

```
set system host log-alias bng endpoint http://192.0.2.0:1102/gelf
set system host log-alias bng endpoint http://192.0.2.0:1102/gelf type gelf
set system host log-alias bng endpoint http://192.0.2.0:1102/gelf network http
set system host log-alias bng endpoint http://192.0.2.0:1102/gelf level info
```

```
{
  "ietf-restconf:data": {
    "rtbrick-config:system": {
      "host": {
        "log-alias": [
```

```
          {
            "name": "bng",
            "endpoint": [
              {
                "address": "http://192.0.2.0:1102/gelf",
                "type": "gelf",
                "network": "http",
                "level": "info"
              }
            ]
          }
        ]
      }
    }
  }
}
```

The following example shows how to configure a plugin alias for a Graylog server with the address http://192.0.2.0:1102/gelf:

```
set system host log-alias graylog endpoint http://192.0.2.0:1102/gelf
set system host log-alias graylog endpoint http://192.0.2.0:1102/gelf type gelf
set system host log-alias graylog endpoint http://192.0.2.0:1102/gelf network http
set system host log-alias graylog endpoint http://192.0.2.0:1102/gelf level info
```

```
{
  "ietf-restconf:data": {
    "rtbrick-config:system": {
      "host": {
        "log-alias": [
          {
            "name": "graylog",
            "endpoint": [
              {
                "address": "http://192.0.2.0:1102/gelf",
                "type": "gelf",
                "network": "http",
                "level": "info"
              }
            ]
          }
        ]
      }
    }
  }
}
```

The following example shows how to configure a plugin alias for a Syslog server using TCP as the transport protocol with the address 198.51.100.0:525:

```
set system host log-alias syslog endpoint 198.51.100.0:525
set system host log-alias syslog endpoint 198.51.100.0:525 type syslog
```

```
set system host log-alias syslog endpoint 198.51.100.0:525 network tcp
```

```
supervisor@rtbrick: cfg> show config
{
  "ietf-restconf:data": {
    "rtbrick-config:system": {
      "host": {
        "log-alias": [
          {
            "name": "syslog",
            "endpoint": [
              {
                "address": "198.51.100.0:525",
                "type": "syslog",
                "network": "tcp"
              }
            ]
          }
        ]
      }
    }
  }
}
```

The following example shows how to configure a plugin alias for a Syslog server using UDP as the transport protocol with the address 198.51.100.0:525:

```
set system host log-alias syslog endpoint 198.51.100.0:525
set system host log-alias syslog endpoint 198.51.100.0:525 type syslog
set system host log-alias syslog endpoint 198.51.100.0:525 network udp
```

```
supervisor@rtbrick: cfg> show config
{
  "ietf-restconf:data": {
    "rtbrick-config:system": {
      "host": {
        "log-alias": [
          {
            "name": "syslog",
            "endpoint": [
              {
                "address": "198.51.100.0:525",
                "type": "syslog",
                "network": "udp"
              }
            ]
          }
        ]
      }
    }
  }
}
```

To access the RESTCONF API that corresponds to this CLI, click here.

Configuring an External Log Server (Plugin Alias) Using In-band Connection

By default, plugins send messages exclusively through the device management interface (eth0 in hardware devices), which is intended for out-of-band management. However, you can also configure an external log server (Plugin Alias) using an in-band connection. This requires in-band to be enabled on RBFS.

Syntax:

set inband-management instance <instance-name> **connection-tracking true**

```
set inband-management instance default connection-tracking true
```



The external log server's IP address must be reachable from the in-band network.

The following example shows how to configure a plugin alias for a Syslog server using UDP as the transport protocol with the address 198.51.100.0:525 via in-band connection:

```
set system host log-alias syslog endpoint 198.51.100.0:525
set system host log-alias syslog endpoint 198.51.100.0:525 type syslog
set system host log-alias syslog endpoint 198.51.100.0:525 network udp
set inband-management instance default connection-tracking true
```

```
supervisor@rtbrick: cfg> show config
{
  "ietf-restconf:data": {
    "rtbrick-config:system": {
      "load-last-config": "true",
      "host": {
        "log-alias": [
          {
            "name": "syslog",
            "endpoint": [
              {
                "address": "198.51.100.0:525",
                "type": "syslog",
                "network": "udp"
              }
            ]
          }
```

```
        ]
      }
    },
    "rtbrick-config:inband-management": {
      "instance": [
        {
          "name": "default",
          "connection-tracking": "true"
        }
      ]
    },
```

11.3.3. Logging Operational Commands

The logging operational commands provide information about the logging operations. They are used to show logs in the system, log configuration status and so on.

BDS Logging

The BDS logging show commands provide information about the BDS logging operations. With the BDS logging operational commands, you can verify BDS logging configuration status and view BDS logs.

Verifying BDS Logging Configuration Status

Show Log Status

This command shows log configuration status for all modules except infrastructure modules in all BDs. The default show log status displays the summary of log status for the whole system and there are options available to show specific module or BD log status.

Syntax:

show log status <attribute> <value>

Option	Description
-	Without any option, the command displays the log configuration status for all modules except infrastructure modules in all BDs.

Option	Description
bd <bd-name>	Displays log status of the all modules including infrastructure in the specified BD.
detail	Displays the log configuration status in detail all the way till log IDs.
module <module-name>	Displays the log status for a given module in all BDs where this module is running.

Example 1: Summary of log status for all modules

```
supervisor@rtbrick: cfg> show log status
Module log status:
  access_service:
    access.serviced:
      Level: error, Plugin: None, Plugin Level: none
      Log group status:
        Group                   Level          Plugin      Plugin Level   Rate limit
        general                 error          None        none           10
        generic                 error          None        none           10
    confd:
      Level: error, Plugin: None, Plugin Level: none
      Log group status:
        Group                   Level          Plugin      Plugin Level   Rate limit
        general                 error          None        none           10
        generic                 error          None        none           10
  bcm_q2c:
    fibd:
      Level: error, Plugin: None, Plugin Level: none
      Log group status:
        Group                   Level          Plugin      Plugin Level   Rate limit
        bds                     error          None        none           10
        config                  error          None        none           10
        ecmp                    error          None        none           10
        general                 error          None        none           10
        generic                 error          None        none           10
        ifl                     error          None        none           10
        l2tp                    error          None        none           10
        l2x                     error          None        none           10
        li                      error          None        none           10
        port                    error          None        none           10
        pppoe                   error          None        none           10
        qos                     error          None        none           10
    confd:
      Level: error, Plugin: None, Plugin Level: none
      Log group status:
        Group                   Level          Plugin      Plugin Level   Rate limit
        bds                     error          None        none           10
        config                  error          None        none           10
        ecmp                    error          None        none           10
        general                 error          None        none           10

<...>
```

Example 2: Summary of log status for the specified module

```
supervisor@rtbrick: cfg>  show log status module bgp
Module log status:
  bgp:
    bgp.iod.1:
      Level: error, Plugin: None, Plugin Level: none
      Log group status:
        Group                   Level          Plugin        Plugin Level   Rate limit
        config                  error          None          none           10
        flowspec                error          None          none           10
        general                 error          None          none           10
        generic                 error          None          none           10
        instance                error          None          none           10
        interface               error          None          none           10
        message                 error          None          none           10
        peer                    error          None          none           10
        validation              error          None          none           10
    bgp.appd.1:
      Level: error, Plugin: None, Plugin Level: none
      Log group status:
        Group                   Level          Plugin        Plugin Level   Rate limit
        config                  error          None          none           10
        flowspec                error          None          none           10
        general                 error          None          none           10
        generic                 error          None          none           10
        instance                error          None          none           10
        interface               error          None          none           10

<...>
```

Example 3: Log status of all modules including infrastructure in the specified BD.

```
supervisor@rtbrick: cfg> show log status bd bgp.appd.1
System/File log status:
  Level: notice

Module log status:
  bd:
    Level: notice, Plugin: None, Plugin Level: none
    Log group status:
      Group                   Level          Plugin        Level          Rate limit
      dns-resolver            notice         None          none           10
      generic                 notice         None          none           10
      http                    notice         None          none           10
      service-launch          notice         None          none           10
      udp                     notice         None          none           10
  bds:
    Level: none, Plugin: None, Plugin Level: none
    Log group status:
      Group                   Level          Plugin        Level          Rate limit
      generic                 none           None          none           10
      object                  none           None          none           10
      table                   none           None          none           10
      trim                    none           None          none           10
  bgp:
    Level: error, Plugin: None, Plugin Level: none
    Log group status:
      Group                   Level          Plugin        Level          Rate limit
```

```
      config                    error          None           none           10
      flowspec                  error          None           none           10
      general                   error          None           none           10
      generic                   error          None           none           10
```

Example 4: Log status for the specified module in the specified BD

```
supervisor@rtbrick: cfg>  show log status module bgp bd bgp.appd.1
Module log status:
  bgp:
    bgp.appd.1:
      Level: error, Plugin: None, Plugin Level: none
      Log group status:
        Group                     Level          Plugin         Plugin Level   Rate limit
        config                    error          None           none           10
        flowspec                  error          None           none           10
        general                   error          None           none           10
        generic                   error          None           none           10
        instance                  error          None           none           10
        interface                 error          None           none           10
        message                   error          None           none           10
        peer                      error          None           none           10
        validation                error          None           none           10
```

Example 5: Detailed Log status for the specified module in the specified BD

```
supervisor@rtbrick>ufi17.q2c.u34.r6.nbg.rtbrick.net: op> show log status bd bgp.appd.1 detail
System/File log status:
  Level: notice

Module log status:
  bd:
    Level: notice, Plugin: None, Plugin Level: none
    Log group status:
      dns-resolver, Level: notice, Plugin: None, Plugin Level: none, Rate limit: 10
     Log ID status:
        LOG ID                                                          Level          Plugin
Level          Rate limit
        BD_UV_DNS_TEMPLATE_MISSING_CB                                   notice         None        none
10
        BD_UV_GETNAMEINFO_FAILED                                        notice         None        none
10
      generic, Level: notice, Plugin: None, Plugin Level: none, Rate limit: 10
      http, Level: notice, Plugin: None, Plugin Level: none, Rate limit: 10
     Log ID status:
        LOG ID                                                          Level          Plugin
Level          Rate limit
        HTTP_CLIENT_REQUEST_LOG                                         notice         None        none
10
        HTTP_JWK_FILE_JSON_PARSE_FAILED                                 notice         None        none
10
        HTTP_JWK_FILE_MEM_ALLOC_FAILED                                  notice         None        none
10
        HTTP_JWK_FILE_MISSING                                           notice         None        none
10
        HTTP_JWK_FILE_OPEN_FAILED                                       notice         None        none
10
        HTTP_JWK_FILE_READ_FAILED                                       notice         None        none
10
        HTTP_JWK_MISSING_KEY                                            notice         None        none
10
        HTTP_JWK_MULTIPLE_KEYS                                          notice         None        none
10
        HTTP_RESP_INSUFFICIENT_BUFFER                                   notice         None        none
10
```

```
        HTTP_SEND                                                       notice          None        none
10
        HTTP_WRITE_BUFFER_MEM_ALLOC_FAILED                              notice          None        none
10
        HTTP_WRITE_PRINTF_FAILED                                        notice          None        none
10
      service-launch, Level: notice, Plugin: None, Plugin Level: none, Rate limit: 10
     Log ID status:
        LOG ID                                                          Level           Plugin
Level          Rate limit
        BD_SERVICE_RESTART                                              notice          None        none
10
        BD_SERVICE_RESTART_FAILED                                       notice          None        none
10
        BD_SERVICE_START                                                notice          None        none
10
        BD_SERVICE_START_FAILED                                         notice          None        none
10
        BD_SERVICE_START_REQUEST                                        notice          None        none
10
        BD_SERVICE_STOP                                                 notice          None        none
10
        BD_SERVICE_STOP_FAILED                                          notice          None        none
10
        BD_SERVICE_STOP_REQUEST                                         notice          None        none
10
      udp, Level: notice, Plugin: None, Plugin Level: none, Rate limit: 10
     Log ID status:
        LOG ID                                                          Level           Plugin
Level          Rate limit

<...>
```

Viewing BDS Logs

Show Log

This command shows BDS logs in the log tables. By default, the command show log shows all logs present in the log tables. Various command options are available to filter and display logs. Also, a command option is available to send logs into a file.

Syntax:

show log <option>

Option	Description
-	Without any option, the command displays all logs present in the log tables.

Option	Description
filter <level> <module>	Render output of the log can be filtered for the specified module or the log level. You can specify filter level or module with any of the view log command, so that the logs are filtered based on the specified level or module.
format <abstract |summary |detailed>	Choose any of the three formats: abstract, summary, or detailed. This command provides output in the specified output format. You can specify any of the options at end of any of the view log commands to show logs in a specific output format. By default, summary is the log format. **Abstract**: Shows logs without metadata **Detailed**: Shows logs in detail with metadata **Summary**: Shows logs in summary view with metadata
table <name>	Displays logs from a specified log table. Every BD includes multiple log tables. By default, log will be rendered from every log table, if not specified.
to file <filename>	Name of the file in which logs are transported. You can specify to file and the file name at end of any view log command to transport the log to the file.
status <bd> <detail> <module>	Displays log configuration status for the specified BD and module. For more information about log configuration status, see the show log status section.

Example 1: Summary view of all logs

```
supervisor@rtbrick: op> show log
[  Notice  ] <2026-03-12T03:38:04.398631+0000> Launch service rtbrick-lldpd, PID 360
[  Notice  ] <2026-03-12T03:38:04.402222+0000> Launch service rtbrick-policy.server, PID 363
[  Notice  ] <2026-03-12T03:38:04.455178+0000> Launch service rtbrick-isis.iod.1, PID 358
[  Notice  ] <2026-03-12T03:38:04.660866+0000> Launch service rtbrick-alertmanager, PID 427
[  Notice  ] <2026-03-12T03:38:05.056040+0000> Launch service rtbrick-ribd, PID 467
[  Notice  ] <2026-03-12T03:38:05.145494+0000> Launch service rtbrick-natd, PID 461
[  Notice  ] <2026-03-12T03:38:05.187485+0000> Launch service rtbrick-mribd, PID 458
[  Notice  ] <2026-03-12T03:38:05.269473+0000> Launch service rtbrick-ifmd, PID 438
[  Notice  ] <2026-03-12T03:38:05.290800+0000> Launch service rtbrick-access.serviced, PID 424
[  Notice  ] <2026-03-12T03:38:05.299252+0000> Launch service rtbrick-bgp.iod.1, PID 434
[  Error   ] <2026-03-12T03:38:05.331521+0000> Failed to launch service rtbrick-fibd
[  Error   ] <2026-03-12T03:38:05.331552+0000> Failed to launch service rtbrick-staticd
[  Error   ] <2026-03-12T03:38:05.331569+0000> Failed to launch service rtbrick-ldp.iod.1
[  Error   ] <2026-03-12T03:38:05.333749+0000> Failed to launch service rtbrick-prometheus
[  Alert   ] <2026-03-12T03:38:14.241096+0000> ISIS instance default, level 1, exit, overload state
```

```
[  Alert   ] <2026-03-12T03:38:14.241144+0000> ISIS instance default, level 2, exit, overload state
[  Alert   ] <2026-03-12T03:40:14.225193+0000> ISIS neighbor 0204.0000.0001.00, discovered, interface ifl-
0/1/26/10, instance default
[  Alert   ] <2026-03-12T03:40:14.430759+0000> ISIS neighbor 0204.0000.0001.00, interface ifl-0/1/26/10,
instance default, changed state from Down, to Up, reason
[  Alert   ] <2026-03-12T05:51:06.607357+0000> ISIS neighbor 0204.0000.0001.00, interface ifl-0/1/26/10,
instance default, changed state from Up, to Down, reason Level mismatch
[  Alert   ] <2026-03-12T03:40:21.973756+0000> BGP FSM change, peer 192.168.0.60, source 192.168.200.1,
hostname -, instance default changed state from Idle to Established, reason None
[  Alert   ] <2026-03-12T03:40:21.974020+0000> BGP FSM change, peer 192.168.0.40, source 192.168.200.1,
hostname -, instance default changed state from Idle to Established, reason None
[  Alert   ] <2026-03-12T03:40:21.974234+0000> BGP FSM change, peer 192.168.0.10, source 192.168.200.1,
hostname -, instance default changed state from Idle to Established, reason None
[  Alert   ] <2026-03-12T03:40:31.756912+0000> BGP FSM change, peer 192.168.0.30, source 192.168.200.1,
hostname -, instance default changed state from Idle to Established, reason None

<...>
```

Example 2: Summary view for the specified log table

```
supervisor@rtbrick: op> show log table bd.confd.log
[  Notice  ] <2026-03-12T03:38:04.398631+0000> Launch service rtbrick-lldpd, PID 360
[  Notice  ] <2026-03-12T03:38:04.402222+0000> Launch service rtbrick-policy.server, PID 363
[  Notice  ] <2026-03-12T03:38:04.455178+0000> Launch service rtbrick-isis.iod.1, PID 358
[  Notice  ] <2026-03-12T03:38:04.660866+0000> Launch service rtbrick-alertmanager, PID 427
[  Notice  ] <2026-03-12T03:38:05.056040+0000> Launch service rtbrick-ribd, PID 467
[  Notice  ] <2026-03-12T03:38:05.145494+0000> Launch service rtbrick-natd, PID 461
[  Notice  ] <2026-03-12T03:38:05.187485+0000> Launch service rtbrick-mribd, PID 458
[  Notice  ] <2026-03-12T03:38:05.269473+0000> Launch service rtbrick-ifmd, PID 438
[  Notice  ] <2026-03-12T03:38:05.290800+0000> Launch service rtbrick-access.serviced, PID 424
[  Notice  ] <2026-03-12T03:38:05.299252+0000> Launch service rtbrick-bgp.iod.1, PID 434
[  Error   ] <2026-03-12T03:38:05.331521+0000> Failed to launch service rtbrick-fibd
[  Error   ] <2026-03-12T03:38:05.331552+0000> Failed to launch service rtbrick-staticd
[  Error   ] <2026-03-12T03:38:05.331569+0000> Failed to launch service rtbrick-ldp.iod.1
[  Error   ] <2026-03-12T03:38:05.333749+0000> Failed to launch service rtbrick-prometheus
```

Example 3: Summary view of specified filters on all logs from a single table

```
supervisor@rtbrick: op> show log table bd.confd.log filter level error
[  Error   ] <2026-03-12T03:38:05.331521+0000> Failed to launch service rtbrick-fibd
[  Error   ] <2026-03-12T03:38:05.331552+0000> Failed to launch service rtbrick-staticd
[  Error   ] <2026-03-12T03:38:05.331569+0000> Failed to launch service rtbrick-ldp.iod.1
[  Error   ] <2026-03-12T03:38:05.333749+0000> Failed to launch service rtbrick-prometheus
```

Example 4: Exporting logs to a file

```
supervisor@rtbrick: op> show log filter level notice to file test.log
supervisor@rtbrick: op> exit
supervisor@rtbrick.net:~ $ cat test.log
[  notice  ] <2026-03-16T05:36:56.169781+0000> Launch service rtbrick-mribd, PID 284
[  notice  ] <2026-03-16T05:36:56.277098+0000> Launch service rtbrick-ribd, PID 287
[  notice  ] <2026-03-16T05:36:56.306515+0000> Launch service rtbrick-staticd, PID 290
[  notice  ] <2026-03-16T05:36:56.328865+0000> Launch service rtbrick-lldpd, PID 280
[  notice  ] <2026-03-16T05:36:56.376332+0000> Launch service rtbrick-ifmd, PID 302
[  notice  ] <2026-03-16T05:36:56.403797+0000> Launch service rtbrick-fibd, PID 321
[  notice  ] <2026-03-16T05:49:59.336664+0000> Launch service rtbrick-bgp.appd.1, PID 1994
[  notice  ] <2026-03-16T05:49:59.359383+0000> Launch service rtbrick-policy.server, PID 1992
[  notice  ] <2026-03-16T05:49:59.365660+0000> Launch service rtbrick-bgp.iod.1, PID 1999
[  notice  ] <2026-03-17T08:56:07.499717+0000> Terminate service rtbrick-lldpd
[  notice  ] <2026-03-17T08:56:07.501850+0000> Terminate service rtbrick-staticd
```

```
[  notice  ] <2026-03-17T08:56:07.514291+0000> Terminate service rtbrick-ribd
[  notice  ] <2026-03-17T08:56:07.516413+0000> Terminate service rtbrick-mribd
[  notice  ] <2026-03-17T08:56:07.518526+0000> Terminate service rtbrick-ifmd
[  notice  ] <2026-03-17T08:56:08.164563+0000> Terminate service rtbrick-fibd
[  notice  ] <2026-03-17T09:08:33.530553+0000> Launch service rtbrick-ribd, PID 33003
[  notice  ] <2026-03-17T09:08:33.530618+0000> Launch service rtbrick-staticd, PID 33013
[  notice  ] <2026-03-17T09:08:33.549244+0000> Launch service rtbrick-mribd, PID 33000
[  notice  ] <2026-03-17T09:08:33.551369+0000> Launch service rtbrick-lldpd, PID 32997
[  notice  ] <2026-03-17T09:08:33.568128+0000> Launch service rtbrick-ifmd, PID 33027
[  notice  ] <2026-03-17T09:08:33.570244+0000> Launch service rtbrick-fibd, PID 33047
```

Example 5: Summary of the logs in an abstract format

```
supervisor@rtbrick: op> show log filter level notice format abstract
Launch service rtbrick-mribd, PID 284
Launch service rtbrick-ribd, PID 287
Launch service rtbrick-staticd, PID 290
Launch service rtbrick-lldpd, PID 280
Launch service rtbrick-ifmd, PID 302
Launch service rtbrick-fibd, PID 321
Launch service rtbrick-bgp.appd.1, PID 1994
Launch service rtbrick-policy.server, PID 1992
Launch service rtbrick-bgp.iod.1, PID 1999
Terminate service rtbrick-lldpd
Terminate service rtbrick-staticd
Terminate service rtbrick-ribd
Terminate service rtbrick-mribd
Terminate service rtbrick-ifmd
Terminate service rtbrick-fibd
Launch service rtbrick-ribd, PID 33003
Launch service rtbrick-staticd, PID 33013
Launch service rtbrick-mribd, PID 33000
Launch service rtbrick-lldpd, PID 32997
Launch service rtbrick-ifmd, PID 33027
Launch service rtbrick-fibd, PID 33047
```

BDS Logging Clear Commands

Clear commands allow you to delete existing logs.

Clear Logs

This commands resets all logs.

Syntax:

clear log <option> <attribute> <value>

Attribute	Description
bd <bd-name>	Clear all BDS logs from the given BD.
table <table-name>	Clears the specified log table.

Viewing RtBrick Host Log Files

RtBrick Host log files are available at the following directory:

CtrlD log files are available at:

/var/log/rtbrick-ctrld.log

Example: CtrlD Logs

```
supervisor@host>rtbrick.net:/var/log $ tail -10 rtbrick-ctrld-service-err.log
time=2026-03-17T10:31:09.180Z level=INFO msg="HTTP request completed"
duration=20.690158ms remote_addr=127.0.0.1:51258 host=localhost:19091 method=GET
path=/api/v1/ctrld/elements request_id=b0aa052b-1025-42a4-80c8-6939a1215f14
statuscode=200 user_name="" user_subject=""
time=2026-03-17T10:31:11.208Z level=INFO msg="HTTP request completed"
duration=25.568185ms remote_addr=127.0.0.1:51258 host=localhost:19091 method=GET
path=/api/v1/ctrld/elements request_id=bc1d8a4b-00bb-4a7e-ba5d-f0f21e90daf4
statuscode=200 user_name="" user_subject=""
time=2026-03-17T10:31:13.120Z level=INFO msg="HTTP request completed"
duration=114.53µs remote_addr=[::1]:33328 host=localhost:19091 method=PUT
path=/api/v1/ctrld/services/hostconfd request_id=f7502b3f-553e-43ed-a08d-
83d0f96e49a7 statuscode=202 user_name="" user_subject=""
time=2026-03-17T10:31:13.198Z level=INFO msg="HTTP request completed"
duration=21.763434ms remote_addr=127.0.0.1:51258 host=localhost:19091 method=GET
path=/api/v1/ctrld/elements request_id=f08d3f11-3777-4bdb-84df-e7694e66add5
statuscode=200 user_name="" user_subject=""
time=2026-03-17T10:31:15.220Z level=INFO msg="HTTP request completed"
duration=19.73206ms remote_addr=127.0.0.1:51258 host=localhost:19091 method=GET
path=/api/v1/ctrld/elements request_id=e01a55d1-c499-4919-9823-4c0256dd92aa
statuscode=200 user_name="" user_subject=""
time=2026-03-17T10:31:17.248Z level=INFO msg="HTTP request completed"
duration=25.172204ms remote_addr=127.0.0.1:51258 host=localhost:19091 method=GET
path=/api/v1/ctrld/elements request_id=9602dd0f-495e-4db8-9692-911d895a233d
statuscode=200 user_name="" user_subject=""
time=2026-03-17T10:31:19.193Z level=INFO msg="HTTP request completed"
duration=17.26797ms remote_addr=127.0.0.1:51258 host=localhost:19091 method=GET
path=/api/v1/ctrld/elements request_id=7f0608b7-79c2-4cc3-82d2-e1346e586139
statuscode=200 user_name="" user_subject=""
time=2026-03-17T10:31:21.222Z level=INFO msg="HTTP request completed"
duration=26.168232ms remote_addr=127.0.0.1:51258 host=localhost:19091 method=GET
path=/api/v1/ctrld/elements request_id=2e4f6cf0-e665-4d6a-93b5-7231ea0af4f3
statuscode=200 user_name="" user_subject=""
time=2026-03-17T10:31:23.201Z level=INFO msg="HTTP request completed"
duration=22.866541ms remote_addr=127.0.0.1:51258 host=localhost:19091 method=GET
path=/api/v1/ctrld/elements request_id=1df66f99-cb9f-44ad-9939-3f20c9ba7aa5
statuscode=200 user_name="" user_subject=""
time=2026-03-17T10:31:25.230Z level=INFO msg="HTTP request completed"
duration=27.259082ms remote_addr=127.0.0.1:51258 host=localhost:19091 method=GET
```

```
path=/api/v1/ctrld/elements request_id=cd8b9c37-ffd6-41ca-8260-06f209d027ac
statuscode=200 user_name="" user_subject=""
```

ApiGwD log files are available at:

/var/log/rtbrick-apigwd.log

Example: API Gateway Logs

```
supervisor@host>rtbrick.net:/var/log $ cat  rtbrick-apigwd-service-err.log
time=2026-03-17T08:43:00.162Z level=INFO msg="watching for file change"
file=/etc/rtbrick/apigwd/config.json
time=2026-03-17T08:43:00.164Z level=INFO msg="Added ip address to the key"
ip=127.0.0.1
time=2026-03-17T08:43:00.164Z level=INFO msg="Added ip address to the key"
ip=10.0.3.1
time=2026-03-17T08:43:00.164Z level=INFO msg="Added ip address to the key" ip=::1
time=2026-03-17T08:43:00.164Z level=INFO msg="Added ip address to the key"
ip=fe80::5e07:58ff:fea2:ce5e
time=2026-03-17T08:43:01.309Z level=INFO msg="Generated new TLS key"
file=/etc/rtbrick/apigwd/tls.pem
time=2026-03-17T08:43:01.315Z level=INFO msg="certificate and key loaded"
time=2026-03-17T08:43:01.315Z level=INFO msg="watching for cert and key change"
time=2026-03-17T08:43:01.315Z level=INFO msg="Serve APIGWD Server" addr=[::]:12321
time=2026-03-17T08:43:53.782Z level=INFO msg="watch event"
event="{Name:/etc/rtbrick/apigwd/config.json Op:2}"
time=2026-03-17T08:43:53.782Z level=INFO msg="reloaded request limiter config"
time=2026-03-17T08:43:53.782Z level=INFO msg="reloaded access config"
time=2026-03-17T08:43:53.940Z level=INFO msg="watch event: WRITE
\"/etc/rtbrick/apigwd/tls.pem\""
time=2026-03-17T08:43:53.942Z level=INFO msg="certificate and key loaded"
```

Viewing Logs in Graylog

For viewing your log data on Graylog, perform the following steps:

1. Open the Graylog webpage.
2. Log in using your user credentials.

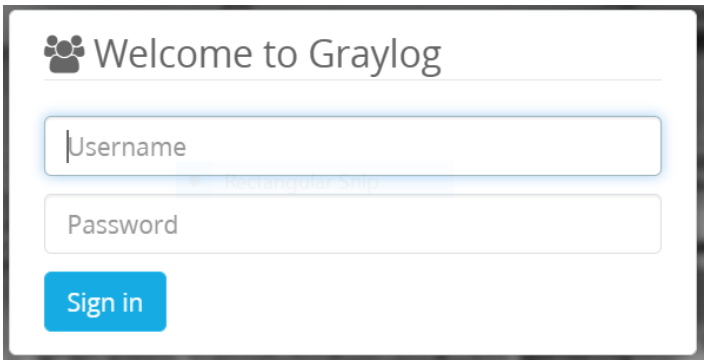


Figure 168. Log Into Graylog

3. Click **System** and select **Input**.

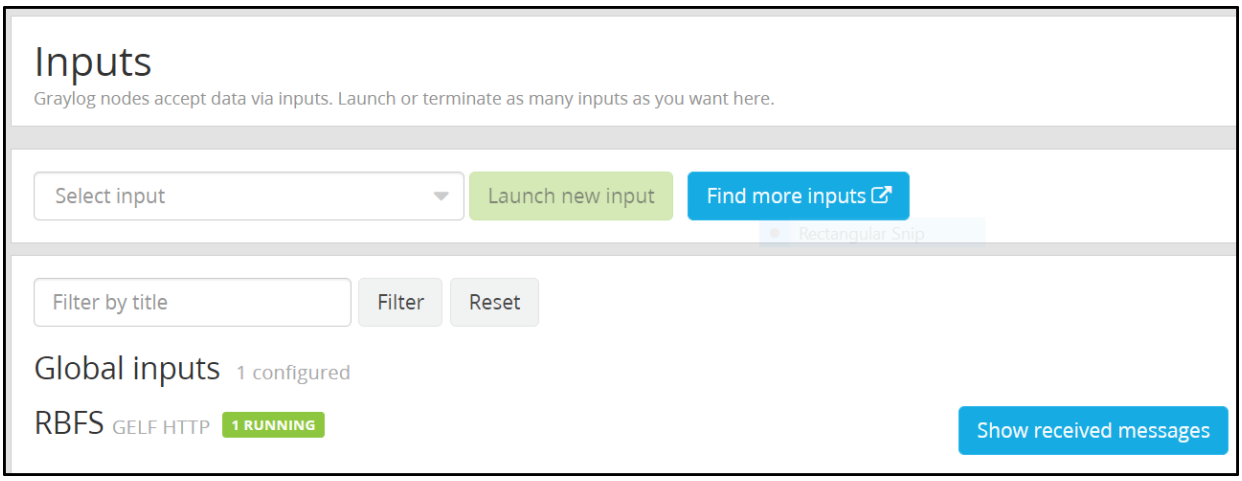


Figure 169. Graylog Inputs

4. Click the **Show received message** tab.

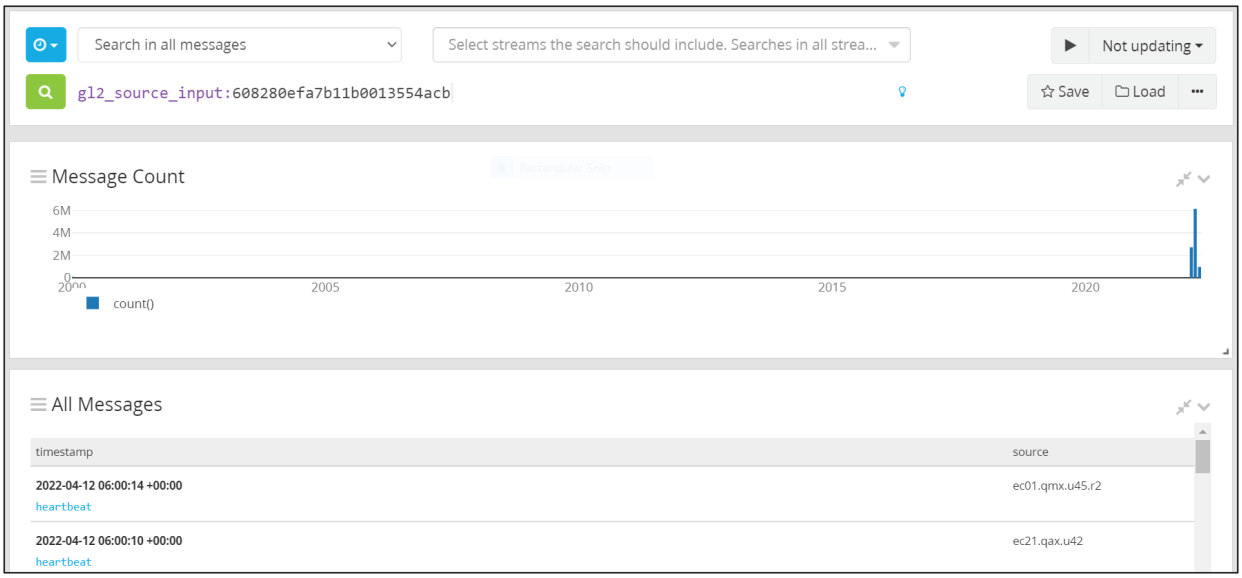


Figure 170. Viewing Logs in Graylog

The log messages page appears.

11.3.4. RBFS Log Reference

RBFS generates logs for various events. RBFS logs are record of events which occur on different functional components or modules in RBFS.

RBFS logs are categorized based on demons or modules from which they are produced. The following are some of the example scenarios when event logs are generated:

- Failure conditions such as failure in decoding received DHCP relay packet or failure to access a configuration file.
- Normal operations such as when an IPoE subscriber is created or deleted and an interface has been configured and so on.
- Critical conditions such as power failure.

This document provides log information such as log ID, message, description and module, severity level and recommended actions.

Log Destination You can locate and view the logs using multiple interfaces which include RBFS command line interface. RBFS also supports exporting logs to external log management servers such as Syslog server and Graylog server for real-time analysis.

You can view the logs in the RBFS command line interface using the show log command. Various command options are available to filter and display logs. For more information, see the Logging Operational Commands section.

bd Log Messages

Log Level Summary

Error(20), Notice(2), Info(5)

Log ID	BD_UV_UDP_BIND_FAILED
Message	UV_UDP: UDP socket bind failed for addr: %s port: %s with error: %s
Description	Failed to bind to local addr and port to create UDP socket
Log Module	bd
Log Group	udp
Severity	ERROR
Recommended Actions	Contact Rtbrick customer support

Log ID	BD_UV_UDP_CONNECT_FAILED

Message	UV_UDP: UDP socket connect failed for remote addr: %s port: %s with error: %s
Description	Failed to connect to remote addr and port to create UDP socket
Log Module	bd
Log Group	udp
Severity	ERROR
Recommended Actions	Contact Rtbrick customer support

Log ID	BD_UV_UDP_INVALID_ADDR_FAMILY
Message	UV_UDP: UDP socket creation failed due to invalid address family %s
Description	Failed to create UDP socket due to invalid address family
Log Module	bd
Log Group	udp
Severity	ERROR
Recommended Actions	Contact Rtbrick customer support

Log ID	BD_UV_UDP_READ_START_FAILED
Message	UV_UDP: Failed to start read on UDP socket add: %s port: %s with error: %s
Description	Failed to start read on UDP socket
Log Module	bd
Log Group	udp
Severity	ERROR
Recommended Actions	Contact Rtbrick customer support

Log ID	BD_UV_UDP_MISSING_CB
Message	UV_UDP: UDP socket create failed due to missing receive or send callback
Description	UDP socket create failed due to missing receive or send callback
Log Module	bd
Log Group	udp
Severity	ERROR
Recommended Actions	Contact Rtbrick customer support

Log ID	BD_UV_DNS_TEMPLATE_MISSING_CB
Message	UV_DNS: DNS getnameinfo failed due to missing paramters
Description	DNS getnameinfo failed due to missing paramters
Log Module	bd
Log Group	dns-resolver
Severity	ERROR
Recommended Actions	Contact Rtbrick customer support

Log ID	BD_UV_GETNAMEINFO_FAILED
Message	UV_DNS: DNS getnameinfo failed to fetch due to %s
Description	DNS getnameinfo failed to fetch
Log Module	bd
Log Group	dns-resolver
Severity	ERROR

Recommended Actions	Contact Rtbrick customer support

Log ID	BD_SERVICE_START_FAILED
Message	Failed to launch service %s
Description	Failed launch new service
Log Module	bd
Log Group	service-launch
Severity	ERROR
Recommended Actions	Contact Rtbrick customer support

Log ID	BD_SERVICE_STOP_FAILED
Message	Failed to terminate service %s
Description	Terminate service
Log Module	bd
Log Group	service-launch
Severity	ERROR
Recommended Actions	Contact Rtbrick customer support

Log ID	BD_SERVICE_RESTART_FAILED
Message	Failed to restart service %s
Description	Failed to restart service
Log Module	bd
Log Group	service-launch
Severity	ERROR

Recommended Actions	Contact Rtbrick customer support

Log ID	HTTP_JWK_FILE_READ_FAILED
Message	Failed to read keys from JWK file %s
Description	Failed to read keys from JWK file
Log Module	bd
Log Group	http
Severity	ERROR
Recommended Actions	Contact Rtbrick customer support

Log ID	HTTP_JWK_MULTIPLE_KEYS
Message	Multiple keys in JWK secret file
Description	Multiple keys in JWK secret file
Log Module	bd
Log Group	http
Severity	ERROR
Recommended Actions	Contact Rtbrick customer support

Log ID	HTTP_JWK_FILE_MISSING
Message	JSON Web Key file %s not found
Description	JSON Web Key file not found
Log Module	bd
Log Group	http
Severity	ERROR

Recommended Actions	Contact Rtbrick customer support

Log ID	HTTP_JWK_FILE_MEM_ALLOC_FAILED
Message	Memory error: unable to allocate %s bytes
Description	Unable to allocate memory to read JSON Wen key file
Log Module	bd
Log Group	http
Severity	ERROR
Recommended Actions	Contact Rtbrick customer support

Log ID	HTTP_JWK_FILE_OPEN_FAILED
Message	Unable to open JWK file %s
Description	Unable to open JWK file
Log Module	bd
Log Group	http
Severity	ERROR
Recommended Actions	Contact Rtbrick customer support

Log ID	HTTP_JWK_MISSING_KEY
Message	Key missing in JWK secret file
Description	Key missing in JWK secret file
Log Module	bd
Log Group	http
Severity	ERROR

Recommended Actions	Contact Rtbrick customer support

Log ID	HTTP_JWK_FILE_JSON_PARSE_FAILED
Message	Failed to parse json content from JWK file %s
Description	Failed to parse json content from JWK file
Log Module	bd
Log Group	http
Severity	ERROR
Recommended Actions	Contact Rtbrick customer support

Log ID	HTTP_WRITE_BUFFER_MEM_ALLOC_FAILED
Message	Failed to allocate memory for HTTP write buffer of size %s
Description	Failed to allocate memory for HTTP write buffer
Log Module	bd
Log Group	http
Severity	ERROR
Recommended Actions	Contact Rtbrick customer support

Log ID	HTTP_WRITE_PRINTF_FAILED
Message	Failed to write data to http write buffer
Description	Failed to write data to http write buffer
Log Module	bd
Log Group	http
Severity	ERROR

Recommended Actions	Contact Rtbrick customer support

Log ID	HTTP_RESP_INSUFFICIENT_BUFFER
Message	Failed to read response body, body len: %s input buffer len: %s
Description	Failed to read response body due to insufficient buffer
Log Module	bd
Log Group	http
Severity	ERROR
Recommended Actions	Contact Rtbrick customer support

Log ID	BD_SERVICE_START
Message	Launch service %s, PID %s
Description	Launch new service
Log Module	bd
Log Group	service-launch
Severity	NOTICE
Recommended Actions	Contact Rtbrick customer support

Log ID	BD_SERVICE_STOP
Message	Terminate service %s
Description	Terminate service
Log Module	bd
Log Group	service-launch

Severity	NOTICE
Recommended Actions	Contact Rtbrick customer support

Log ID	BD_SERVICE_START_REQUEST
Message	%s module requested to launch %s service
Description	Service launch request from module
Log Module	bd
Log Group	service-launch
Severity	INFO
Recommended Actions	Contact Rtbrick customer support

Log ID	BD_SERVICE_STOP_REQUEST
Message	%s module requested to terminate service %s
Description	Service terminate request from module
Log Module	bd
Log Group	service-launch
Severity	INFO
Recommended Actions	Contact Rtbrick customer support

Log ID	BD_SERVICE_RESTART
Message	Restart service %s, PID %s
Description	Restart new service
Log Module	bd
Log Group	service-launch

Severity	INFO
Recommended Actions	Contact Rtbrick customer support

Log ID	HTTP_SEND
Message	Send response for request endpoint %s %s buf count %s state %s
Description	Send response details
Log Module	bd
Log Group	http
Severity	INFO
Recommended Actions	Contact Rtbrick customer support

Log ID	HTTP_CLIENT_REQUEST_LOG
Message	method: %s path: %s request body: %s response code: %s response body: %s
Description	Log http request and response
Log Module	bd
Log Group	http
Severity	INFO
Recommended Actions	Contact Rtbrick customer support

BGP Log Messages

Log Level Summary

Alert(1), Notice(1), Info(45), Debug(16)

Log ID	BGP_PEER_STATE_CHANGE
Message	BGP FSM change, peer %s, source %s, hostname %s, instance %s changed state from %s to %s, reason %s
Description	BGP FSM state change log
Log Module	bgp
Log Group	peer
Severity	Alert
Recommended Actions	Contact Rtbrick customer support

Log ID	BGP_PEER_RESET
Message	BGP peer %s, source %s, hostname %s, instance %s reset, reason %s
Description	BGP Session reset
Log Module	bgp
Log Group	peer
Severity	Notice
Recommended Actions	Contact Rtbrick customer support

Log ID	BGP_IFL_NBR_ADD
Message	Link-local peer %s discovered on interface %s, instance %s
Description	BGP Link-local peer discovered on interface
Log Module	bgp
Log Group	peer
Severity	info
Recommended Actions	Contact Rtbrick customer support

Log ID	BGP_IFL_NBR_DEL
Message	Link-local peer %s deleted on interface %s, instance %s
Description	BGP Link-local peer deleted on interface
Log Module	bgp
Log Group	peer
Severity	info
Recommended Actions	Contact Rtbrick customer support

Log ID	BGP_PEER_RESET_FSM_ERR
Message	BGP peer %s, source %s, hostname %s, instance %s reset, reason FSM error subcode %s, message type %s
Description	BGP Session reset due to FSM error
Log Module	bgp
Log Group	peer
Severity	Info
Recommended Actions	Contact Rtbrick customer support

Log ID	BGP_MSG_OPEN_VERSION
Message	BGP peer %s, source %s, hostname %s, instance %s received open message with version %s
Description	BGP peer %s, source %s, hostname %s, instance %s received open message with unsupported version
Log Module	bgp
Log Group	peer
Severity	Info

Recommended Actions	Contact Rtbrick customer support

Log ID	BGP_MSG_OPEN_IDENTIFIER
Message	BGP Open message received with bad identifier %s
Description	BGP Open message received with bad identifier
Log Module	bgp
Log Group	peer
Severity	Info
Recommended Actions	Contact Rtbrick customer support

Log ID	BGP_MSG_OPEN_HOLDTIMER
Message	BGP peer %s, source %s, hostname %s, instance %s received open message with illegal hold timer %s
Description	BGP Open message received with bad hold timer value
Log Module	bgp
Log Group	peer
Severity	Info
Recommended Actions	Contact Rtbrick customer support

Log ID	BGP_INVALID_RECEIVED_AS
Message	BGP peer %s, source %s, hostname %s, instance %s received wrong AS %s, expected AS %s
Description	BGP Received wrong AS number from remote peer
Log Module	bgp
Log Group	peer

Severity	Info
Recommended Actions	Contact Rtbrick customer support

Log ID	BGP_MSG_MANDATORY_ATTRIBUTE
Message	BGP peer %s, source %s, hostname %s, instance %s received message %s with mandatory parameter %s missing
Description	BGP message mandatory parameter missing
Log Module	bgp
Log Group	peer
Severity	Info
Recommended Actions	Contact Rtbrick customer support

Log ID	BGP_PEER_RESET_MSG_HDR_LEN_ERR
Message	BGP peer %s, source %s, hostname %s, instance %s is reset, reason: invalid message header length %s
Description	BGP peer reset log for invalid header length
Log Module	bgp
Log Group	peer
Severity	Info
Recommended Actions	Contact Rtbrick customer support

Log ID	BGP_PEER_RESET_INVALID_TYPE
Message	BGP peer %s, source %s, hostname %s, instance %s is reset, reason: invalid message type %s, length %s
Description	BGP peer reset log for invalid message type

Log Module	bgp
Log Group	peer
Severity	Info
Recommended Actions	Contact Rtbrick customer support

Log ID	BGP_PEER_RESET_INVALID_PARAMETER_TYPE
Message	BGP peer %s, source %s, hostname %s, instance %s is reset, reason: invalid optional parameter, message %u, parameter type %u
Description	BGP peer reset log for invalid optional parameter type
Log Module	bgp
Log Group	peer
Severity	Info
Recommended Actions	Contact Rtbrick customer support

Log ID	BGP_PEER_RESET_INVALID_CAP_LEN
Message	BGP peer %s, source %s hostname %s, instance %s is reset, reason: invalid capability type %s, capability length %s
Description	BGP peer reset log for invalid capability length
Log Module	bgp
Log Group	peer
Severity	Info
Recommended Actions	Contact Rtbrick customer support

Log ID	BGP_DUPLICATE_TCP_ACCEPT

Message	BGP peer %s, source %s, hostname %s, instance %s duplicate accept socket is success.
Description	BGP Duplicate accept socket success
Log Module	bgp
Log Group	peer
Severity	Info
Recommended Actions	Contact Rtbrick customer support

Log ID	BGP_IFL_CHANGE
Message	Interface %s, instance %s received event %s
Description	Interface status change event
Log Module	bgp
Log Group	interface
Severity	Info
Recommended Actions	Contact Rtbrick customer support

Log ID	BGP_IFA_CHANGE
Message	Interface %s, instance %s received %s of address %s
Description	Interface address event
Log Module	bgp
Log Group	interface
Severity	info
Recommended Actions	Contact Rtbrick customer support

Log ID	BGP_INSTANCE_INACTIVE
Message	Instance %s is inactive, reason %s
Description	BGP Instance is inactive
Log Module	bgp
Log Group	instance
Severity	info
Recommended Actions	Contact Rtbrick customer support

Log ID	BGP_MSG_VALIDATION_FAIL
Message	BGP message received from peer %s, source %s, hostname %s, instance %s validation failed. Message type %s
Description	BGP Message validation failure
Log Module	bgp
Log Group	message
Severity	Info
Recommended Actions	Contact Rtbrick customer support

Log ID	BGP_MSG_DECODE_FAIL
Message	BGP message received from peer %s, source %s, hostname %s, instance %s decode failed. Message type %s
Description	BGP Message decode failure
Log Module	bgp
Log Group	message
Severity	Info
Recommended Actions	Contact Rtbrick customer support

Log ID	BGP_UPD_SET_ERR_INFO
Message	Update processing error. code %s , subcode %s
Description	BGP Update processing error code and subcode
Log Module	bgp
Log Group	message
Severity	info
Recommended Actions	Contact Rtbrick customer support

Log ID	BGP_UPD_INVALID_IPV4_PREFIX
Message	BGP update message processing, peer %s, source %s, hostname %s, instance %s: Received invalid prefix %s/%s
Description	BGP Update message received with invalid prefix
Log Module	bgp
Log Group	message
Severity	Info
Recommended Actions	Contact Rtbrick customer support

Log ID	BGP_UPD_ATTR_REPEAT
Message	BGP update message processing, peer %s, source %s, hostname %s, instance %s: Attribute %s repeated
Description	BGP Update message with attribute repeated
Log Module	bgp
Log Group	message
Severity	Info

Recommended Actions	Contact Rtbrick customer support

Log ID	BGP_UPD_ATTR_WELLKNOWN_TRANS
Message	BGP update message processing, peer %s, source %s, hostname %s, instance %s: Attribute %s does not have well known transitive flag set
Description	BGP Update processing error: Attribute does not have well known transitive flag set
Log Module	bgp
Log Group	message
Severity	Info
Recommended Actions	Contact Rtbrick customer support

Log ID	BGP_UPD_ATTR_WK_TRANS_PARTIAL
Message	BGP update message processing, peer %s, source %s, hostname %s, instance %s: Well known transitive attribute %s has partial bit set
Description	BGP Update processing error: Well known transitive attribute has partial bit set
Log Module	bgp
Log Group	message
Severity	Info
Recommended Actions	Contact Rtbrick customer support

Log ID	BGP_UPD_ATTR_INVALID_ASPATH_LEN

Message	BGP update message processing, peer %s, source %s, hostname %s, instance %s: Invalid AS path length %s
Description	BGP Update processing: Invalid AS path length
Log Module	bgp
Log Group	message
Severity	Info
Recommended Actions	Contact Rtbrick customer support

Log ID	BGP_UPD_ENFORCE_FIRST_AS
Message	BGP update message processing, peer %s, source %s, hostname %s, instance %s: First AS %s is not peer AS %s, ignoring
Description	BGP Update processing: First AS is not peer AS, so ignore the update
Log Module	bgp
Log Group	message
Severity	Info
Recommended Actions	Contact Rtbrick customer support

Log ID	BGP_UPD_INVALID_SEG_TYPE
Message	BGP update message processing, peer %s, source %s, hostname %s, instance %s: Invalid path segment type %s
Description	BGP Update processing: Invalid segment type
Log Module	bgp
Log Group	message
Severity	Info

Recommended Actions	Contact Rtbrick customer support

Log ID	BGP_UPD_INVALID_NH
Message	BGP update message processing, peer %s, source %s, hostname %s, instance %s: Invalid unicast ip address in nexthop %s
Description	BGP Update processing: Invalid unicast ip address in nexthop
Log Module	bgp
Log Group	message
Severity	Info
Recommended Actions	Contact Rtbrick customer support

Log ID	BGP_UPD_INVALID_IP6_PREFIX
Message	BGP update message processing, peer %s, source %s, hostname %s, instance %s: Invalid prefix %s/%s
Description	BGP Update processing Invalid ipv6 prefix
Log Module	bgp
Log Group	message
Severity	Info
Recommended Actions	Contact Rtbrick customer support

Log ID	BGP_UPD_RCVD_NON_NEGOTIATED_AF
Message	BGP update message processing, peer %s, source %s, hostname %s, instance %s: Received NLRI of non-negotiated address family %s, safi %s

Description	BGP Update processing: Received NLRI of non-negotiated address family
Log Module	bgp
Log Group	message
Severity	Info
Recommended Actions	Contact Rtbrick customer support

Log ID	BGP_UPD_INVALID_LEN
Message	BGP update message processing, peer %s, source %s, hostname %s, instance %s: Received invalid length %s
Description	BGP Update processing: Received invalid length
Log Module	bgp
Log Group	message
Severity	Info
Recommended Actions	Contact Rtbrick customer support

Log ID	BGP_UPD_MALFORMED_PATH_ATTR
Message	BGP update message processing, peer %s, source %s, hostname %s, instance %s: Received malformed path attribute %s, length %s
Description	BGP Update processing: Received malformed path attribute
Log Module	bgp
Log Group	message
Severity	Info
Recommended Actions	Contact Rtbrick customer support

Log ID	BGP_UPD_ATTR_EXT_LEN
Message	BGP update message processing, peer %s, source %s, hostname %s, instance %s: Invalid length bit set for attribute %s
Description	BGP Update processing: Invalid length bit set for attribute
Log Module	bgp
Log Group	message
Severity	Info
Recommended Actions	Contact Rtbrick customer support

Log ID	BGP_UPD_ATTR_INVALID_ORIGIN
Message	BGP update message processing, peer %s, source %s, hostname %s, instance %s: Invalid origin attribute value %s
Description	BGP Update processing: Invalid origin attribute value
Log Module	bgp
Log Group	message
Severity	Info
Recommended Actions	Contact Rtbrick customer support

Log ID	BGP_UPD_ATTR_OPTIONAL_TRANS
Message	BGP update message processing, peer %s, source %s, hostname %s, instance %s: Attribute %s does not have optional transitive flag set
Description	BGP Update processing: Attribute does not have optional transitive flag set
Log Module	bgp
Log Group	message

Severity	Info
Recommended Actions	Contact Rtbrick customer support

Log ID	BGP_UPD_OWN_ROUTER_ID
Message	BGP update message processing, peer %s, source %s, hostname %s, instance %s: Received own router id %s
Description	BGP Update processing: Received own router ID
Log Module	bgp
Log Group	message
Severity	Info
Recommended Actions	Contact Rtbrick customer support

Log ID	BGP_UPD_ATTR_OPTIONAL_NON_TRANS
Message	BGP update message processing, peer %s, source %s, hostname %s, instance %s: Attribute %s does not have optional non-transitive flag set
Description	BGP Update processing: Attribute does not have optional non-transitive flag set
Log Module	bgp
Log Group	message
Severity	Info
Recommended Actions	Contact Rtbrick customer support

Log ID	BGP_UPD_INVALID_ATTR_EBGP

Message	BGP update message processing, peer %s, source %s, hostname %s, instance %s: Received invalid attribute %s from EBGP peer
Description	BGP Update processing: Received invalid attribute from EBGP peer
Log Module	bgp
Log Group	message
Severity	Info
Recommended Actions	Contact Rtbrick customer support

Log ID	BGP_UPD_INVALID_SR_IDX_LEN
Message	BGP update message processing, peer %s, source %s, hostname %s, instance %s: Invalid SR index length %s
Description	BGP Update processing: Invalid SR index length
Log Module	bgp
Log Group	message
Severity	Info
Recommended Actions	Contact Rtbrick customer support

Log ID	BGP_UPD_INVALID_SRGB_LEN
Message	BGP update message processing, peer %s, source %s, hostname %s, instance %s: Invalid SRGB length %s
Description	BGP Update processing: Invalid SRGB length
Log Module	bgp
Log Group	message
Severity	Info

Recommended Actions	Contact Rtbrick customer support

Log ID	BGP_UPD_PATH_ATTR_FAIL
Message	BGP update message processing, peer %s, source %s, hostname %s, instance %s: Processing path attribute failed
Description	BGP Update processing: Processing path attribute failed
Log Module	bgp
Log Group	message
Severity	Info
Recommended Actions	Contact Rtbrick customer support

Log ID	BGP_UPD_MREACH_FAIL
Message	BGP update message processing, peer %s, source %s, hostname %s, instance %s: Processing MPREACH NLRI attribute failed
Description	BGP Update processing: Processing MPREACH NLRI attribute failed
Log Module	bgp
Log Group	message
Severity	Info
Recommended Actions	Contact Rtbrick customer support

Log ID	BGP_UPD_INVALID_EXP_LEN
Message	BGP update message processing, peer %s, source %s, hostname %s, instance %s: Received invalid length %s . Expected %s

Description	BGP Update processing: Received invalid length
Log Module	bgp
Log Group	message
Severity	Info
Recommended Actions	Contact Rtbrick customer support

Log ID	BGP_UPD_NLRI_FAIL
Message	BGP update message processing, peer %s, source %s, hostname %s, instance %s: Processing NLRI attribute failed
Description	BGP Update processing: Processing NLRI attribute failed
Log Module	bgp
Log Group	message
Severity	Info
Recommended Actions	Contact Rtbrick customer support

Log ID	BGP_FSM_PEER_STATE_CHANGE
Message	Peer [%s] Src[%s] CurState[%s] Event[%s] NextState[%s]
Description	BGP Update processing: Processing NLRI attribute failed
Log Module	bgp
Log Group	message
Severity	Info
Recommended Actions	Contact Rtbrick customer support

Log ID	BGP_UPD_FLOWSPEC_INVALID_LEN

Message	BGP flowspec update message processing, peer %s, source %s, hostname %s, instance %s: Received invalid flowspec nlri(%s)
Description	BGP Update processing: Received invalid length
Log Module	bgp
Log Group	message
Severity	Info
Recommended Actions	Contact Rtbrick customer support

Log ID	BGP_NO_ROUTER_ID
Message	Router ID is not present in instance %s
Description	BGP Router ID is present
Log Module	bgp
Log Group	peer
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	BGP_NO_LOCAL_AS
Message	Local AS is not configured in instance %s
Description	BGP Local AS is not configured
Log Module	bgp
Log Group	peer
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	BGP_FLOWSPEC_RECEIVED
Message	Flowspec rule %s received from Peer(peer:%s, src:%s), flowspec hash (%s)
Description	BGP Flowspec update/withdraw received
Log Module	bgp
Log Group	flowspec
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	BGP_FLOWSPEC_SEND
Message	Flowspec rule %s send to Peer(peer:%s, src:%s), (flowspec hash: %s)
Description	BGP Flowspec send to peer
Log Module	bgp
Log Group	flowspec
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	BGP_FLOWSPEC_RULE_INVALID
Message	Flowspec rule (flowspec hash: %s) not updated
Description	BGP Flowspec not updated
Log Module	bgp
Log Group	flowspec
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	BGP_FLOWSPEC_ENTRY_DELETED
Message	Flowspec rule (flowspec hash: %s) deleted
Description	BGP Flowspec rule deleted
Log Module	bgp
Log Group	flowspec
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	BGP_FLOWSPEC_PRIORITY_ADDED
Message	Flowspec rule (flowspec hash: %s) added at index %s
Description	BGP Flowspec rule priority added
Log Module	bgp
Log Group	flowspec
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	BGP_FLOWSPEC_ACL_ADDED
Message	Flowspec rule (flowspec hash: %s) added with priority %s and acl count %s
Description	BGP Flowspec rule acl added
Log Module	bgp
Log Group	flowspec
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	BGP_FLOWSPEC_ACL_DELETED
Message	Flowspec rule (flowspec hash: %s) deleted with priority %s and acl count %s
Description	BGP Flowspec rule acl deleted
Log Module	bgp
Log Group	flowspec
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	BGP_FLOWSPEC_ACL_REINSTALLED
Message	Flowspec rule (flowspec hash: %s) reinstalled with priority %s and acl count %s
Description	BGP Flowspec rule acl reinstalled
Log Module	bgp
Log Group	flowspec
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	BGP_FLOWSPEC_PRIORITY_DELETED
Message	Flowspec rule (flowspec hash: %s) at index %s deleted
Description	BGP Flowspec rule priority deleted
Log Module	bgp
Log Group	flowspec
Severity	debug

Recommended Actions	Contact Rtbrick customer support

Log ID	BGP_FLOWSPEC_PRIORITY_UPDATED
Message	Flowspec rule (flowspec hash: %s) priority updated from %s to %s acl-full:%s status:%s
Description	BGP Flowspec rule priority updated
Log Module	bgp
Log Group	flowspec
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	BGP_FLOWSPEC_PRIORITY_FULL
Message	Flowspec rule (flowspec hash: %s) not sorted as the max rule count %s reached
Description	BGP Flowspec rule not sorted
Log Module	bgp
Log Group	flowspec
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	BGP_FLOWSPEC_PRIORITY_NOT_FOUND
Message	Flowspec rule (flowspec hash: %s) not found in priority sorting
Description	BGP Flowspec rule not found
Log Module	bgp

Log Group	flowspec
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	BGP_FLOWSPEC_PRIORITY_FOUND
Message	Flowspec rule (flowspec hash: %s) found in priority sorting at index %s
Description	BGP Flowspec rule found
Log Module	bgp
Log Group	flowspec
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	BGP_FLOWSPEC_STATUS_INVALID
Message	Status invalid flowspec(%s)
Description	Invalid status
Log Module	bgp
Log Group	flowspec
Severity	debug
Recommended Actions	Contact Rtbrick customer support

nat Log Messages

Log Level Summary

Warning(1), Notice(3)

Log ID	NAT_LOG_POOL_RESOURCE_STATUS
Message	Pool exhaustion, status %s, pool %s, instance %s
Description	Resource Usage Status
Log Module	nat
Log Group	nat-resource
Severity	warning
Recommended Actions	Contact Rtbrick customer support

Log ID	NAT_LOG_USER_ADDR_PORT_ALLOC
Message	IPv4 Address Allocated, User %s, Original Address %s, Translated Address %s, L4-Port-Range %s - %s
Description	User IPv4 Address and Port-Range Allocated
Log Module	nat
Log Group	nat-resource
Severity	notice
Recommended Actions	Contact Rtbrick customer support

Log ID	NAT_LOG_USER_ADDR_PORT_FREE
Message	IPv4 Address Freed, User %s, Original Address %s, Translated Address %s, L4-Port-Range %s - %s
Description	User IPv4 Address and Port-Range Freed
Log Module	nat
Log Group	nat-resource
Severity	notice
Recommended Actions	Contact Rtbrick customer support

Log ID	NAT_LOG_RULE_USAGE_STATUS
Message	Max rules, status %s, subscriber %s
Description	Address Translation Rules Usage of a Subsciber
Log Module	nat
Log Group	nat-resource
Severity	notice
Recommended Actions	Contact Rtbrick customer support

rtbrick-cli Log Messages

Log Level Summary

Info(1)

Log ID	CLI_BACKEND_COMMAND_EXECUTION_LOG
Message	%s
Description	Command executed via cli/restconf
Log Module	rtbrick-cli
Log Group	cli-execution
Severity	info
Recommended Actions	Contact Rtbrick customer support

hostconfd Log Messages

Log Level Summary

Error(5), Info(6)

Log ID	HOSTCONFD_ALERTING_CONFIG_ERROR
Message	HOSTCONFD alert config error {event:%s}
Description	Error reported by hostconfd on alerting configuration error
Log Module	hostconfd
Log Group	functional
Severity	ERROR
Recommended Actions	Check the hostconfd operational status

Log ID	IPMI_CONFIG_TABLE_ERROR
Message	Failed to create IPMI config table %s
Description	Failed to create IPMI config table
Log Module	hostconfd
Log Group	functional
Severity	ERROR
Recommended Actions	Contact Rtbrick customer support

Log ID	WATCHDOG_CONFIG_TABLE_ERROR
Message	Failed to create Watchdog config table %s
Description	Failed to create Watchdog config table
Log Module	hostconfd
Log Group	functional
Severity	ERROR
Recommended Actions	Contact Rtbrick customer support

Log ID	SNMP_CONFIG_TABLE_ERROR
Message	Failed to create snmp config table %s
Description	Failed to create snmp config table
Log Module	hostconfd
Log Group	functional
Severity	ERROR
Recommended Actions	Contact Rtbrick customer support

Log ID	FAIL2BAN_CONFIG_TABLE_ERROR
Message	Failed to create fail2ban config table %s
Description	Failed to create fail2ban config table
Log Module	hostconfd
Log Group	functional
Severity	ERROR
Recommended Actions	Contact Rtbrick customer support

Log ID	HOSTCONFD_BDS_GENERIC_FAIL
Message	Failed due to bds events- {table:%s}
Description	Failed due to bds events
Log Module	hostconfd
Log Group	bds
Severity	INFO
Recommended Actions	Check table/object in the bds commands

Log ID	HOSTCONFD_TABLE_CONFIG_READ_FAIL
Message	Failed to read static hostconfd table configuration- {file:%s}
Description	Failed to read static hostconfd table configuration
Log Module	hostconfd
Log Group	config
Severity	INFO
Recommended Actions	Check the json format/table-name in the file

Log ID	HOSTCONFD_DYN_PLUGIN_REGN_FAIL
Message	Failed to register dynamic plugin- {table-type:%s}
Description	Failed to register dynamic plugin
Log Module	hostconfd
Log Group	config
Severity	INFO
Recommended Actions	Check the table definition

Log ID	HOSTCONFD_HTTP_HEADER_FAIL
Message	Failed to create HTTP header to send to hostconfd {event:%s}
Description	Failed to create HTTP header to send to hostconfd
Log Module	hostconfd
Log Group	functional
Severity	INFO
Recommended Actions	Check the table definition

Log ID	HOSTCONFD_HTTP_CONTENT_FAIL
Message	Failed to create HTTP content to send to hostconfd- {table-type:%s}
Description	Failed to create HTTP content to send to hostconfd
Log Module	hostconfd
Log Group	functional
Severity	INFO
Recommended Actions	Check the table deifinition

Log ID	HOSTCONFD_CONNECTION_DOWN
Message	HOSTCONFD connection is DOWN {event:%s}
Description	HOSTCONFD connection is DOWN
Log Module	hostconfd
Log Group	functional
Severity	INFO
Recommended Actions	Check the hostconfd operational status

Interfaces Log Messages

Log Level Summary

Info(20)

Log ID	IFM_OPER_IFP_ADMIN_UP
Message	Admin status of the physical interface %s is UP
Description	Interface configuration change triggered
Log Module	ifm
Log Group	config

Severity	info
Recommended Actions	Check the interface configurations for this physical interface

Log ID	IFM_OPER_IFP_ADMIN_DOWN
Message	Admin status of the physical interface %s is DOWN
Description	Interface configuration change triggered
Log Module	ifm
Log Group	config
Severity	info
Recommended Actions	Check the interface configurations for this physical interface

Log ID	IFM_OPER_IFP_LINK_UP
Message	Link status of the physical interface %s is UP
Description	Interface link events triggered
Log Module	ifm
Log Group	interface-events
Severity	info
Recommended Actions	Check the physical connection for this particular port

Log ID	IFM_OPER_IFP_LINK_DOWN
Message	Link status of the physical interface %s is DOWN
Description	Interface link events triggered
Log Module	ifm
Log Group	interface-events

Severity	info
Recommended Actions	Check the physical connection for this particular port

Log ID	IFM_OPER_IFP_OPERATIONAL_UP
Message	Operational status of the physical interface %s is UP
Description	Interface config or link events triggered
Log Module	ifm
Log Group	interface-events
Severity	info
Recommended Actions	Check the physical connection for this particular port or the interface configuration

Log ID	IFM_OPER_IFP_OPERATIONAL_DOWN
Message	Operational status of the physical interface %s is DOWN
Description	Interface config or link events triggered
Log Module	ifm
Log Group	interface-events
Severity	info
Recommended Actions	Check the physical connection for this particular port or the interface configuration

Log ID	IFM_OPER_IFL_ADMIN_UP
Message	Admin status of the logical interface %s is UP
Description	Interface configuration change triggered
Log Module	ifm
Log Group	config

Severity	info
Recommended Actions	Check the interface configurations for this logical interface

Log ID	IFM_OPER_IFL_ADMIN_DOWN
Message	Admin status of the logical interface %s is DOWN
Description	Interface configuration change triggered
Log Module	ifm
Log Group	config
Severity	info
Recommended Actions	Check the interface configurations for this logical interface

Log ID	IFM_OPER_IFL_LINK_UP
Message	Link status of the logical interface %s is UP
Description	Interface link events triggered
Log Module	ifm
Log Group	interface-events
Severity	info
Recommended Actions	Check the physical connection for this particular port

Log ID	IFM_OPER_IFL_LINK_DOWN
Message	The link status of the logical interface %s is DOWN
Description	Interface link events triggered
Log Module	ifm
Log Group	interface-events

Severity	info
Recommended Actions	Check the physical connection for this particular port

Log ID	IFM_OPER_IFL_OPERATIONAL_UP
Message	Operational status of the logical interface %s is UP
Description	Interface config or link events triggered
Log Module	ifm
Log Group	interface-events
Severity	info
Recommended Actions	Check the physical connection for this particular port or the logical interface configuration

Log ID	IFM_OPER_IFL_OPERATIONAL_DOWN
Message	The operational status of the logical interface %s is DOWN
Description	Interface config or link events triggered
Log Module	ifm
Log Group	interface-events
Severity	info
Recommended Actions	Check the physical connection for this particular port or the logical interface configuration

Log ID	IFM_OPER_IFL_IPV4_STATUS_UP
Message	IPv4 status of the logical interface %s is UP
Description	Logical Interface configuration change triggered
Log Module	ifm
Log Group	config

Severity	info
Recommended Actions	Check the ipv4 status for this logical interface

Log ID	IFM_OPER_IFL_IPV4_STATUS_DOWN
Message	IPv4 status of the logical interface %s is DOWN
Description	Logical Interface configuration change triggered
Log Module	ifm
Log Group	config
Severity	info
Recommended Actions	Check the ipv4 status for this logical interface

Log ID	IFM_OPER_IFL_IPV6_STATUS_UP
Message	IPv6 status of the logical interface %s is UP
Description	Logical Interface configuration change triggered
Log Module	ifm
Log Group	config
Severity	info
Recommended Actions	Check the ipv6 status for this logical interface

Log ID	IFM_OPER_IFL_IPV6_STATUS_DOWN
Message	IPv6 status of the logical interface %s is DOWN
Description	Logical Interface configuration change triggered
Log Module	ifm
Log Group	config

Severity	info
Recommended Actions	Check the ipv6 status for this logical interface

Log ID	IFM_OPER_IFL_MPLS_STATUS_UP
Message	The MPLS status of the logical interface %s is UP
Description	Logical Interface configuration change triggered
Log Module	ifm
Log Group	config
Severity	info
Recommended Actions	Check the mpls status for this logical interface

Log ID	IFM_OPER_IFL_MPLS_STATUS_DOWN
Message	MPLS status of the logical interface %s is DOWN
Description	Logical Interface configuration change triggered
Log Module	ifm
Log Group	config
Severity	info
Recommended Actions	Check the mpls status for this logical interface

Log ID	IFM_OPER_IFP_HOLDDOWN_START
Message	The holddown machinery for the physical interface %s is activated
Description	Interface config or link events triggered
Log Module	ifm

Log Group	interface-events
Severity	info
Recommended Actions	Check the physical connection for this particular port or its configuration

Log ID	IFM_OPER_IFP_HOLDDOWN_STOP
Message	The holddown machinery for the physical interface %s is deactivated after %s carrier transitions
Description	Interface config or link events triggered
Log Module	ifm
Log Group	interface-events
Severity	info
Recommended Actions	Check the physical connection for this particular port or its configuration

IPoE Log Messages

Log Level Summary

Info(17), Debug(24)

Log ID	SUBSCRIBER_CREATED
Message	IPoE subscriber %s created for %s.%s:%s %s
Description	IPoE subscriber created
Log Module	ipoe
Log Group	subscriber
Severity	info
Recommended Actions	Contact Rtbrick customer support

Log ID	SUBSCRIBER_DELETED
Message	IPoE subscriber %s deleted with terminate code %s
Description	IPoE subscriber deleted
Log Module	ipoe
Log Group	subscriber
Severity	info
Recommended Actions	Contact Rtbrick customer support

Log ID	DHCP_BINDING_CREATED
Message	IPoE subscriber %s DHCP binding created
Description	Subscriber DHCP binding created
Log Module	ipoe
Log Group	dhcp
Severity	info
Recommended Actions	Contact Rtbrick customer support

Log ID	DHCP_BINDING_DELETED
Message	IPoE subscriber %s DHCP binding deleted
Description	Subscriber DHCP binding deleted
Log Module	ipoe
Log Group	dhcp
Severity	info
Recommended Actions	Contact Rtbrick customer support

Log ID	DHCP_BINDING_EXPIRED
Message	IPoE subscriber %s DHCP binding lease timer expired
Description	Subscriber DHCP binding lease expired
Log Module	ipoe
Log Group	dhcp
Severity	info
Recommended Actions	Contact Rtbrick customer support

Log ID	DHCPV6_BINDING_CREATED
Message	IPoE subscriber %s DHCPv6 binding created
Description	Subscriber DHCPv6 binding created
Log Module	ipoe
Log Group	dhcp
Severity	info
Recommended Actions	Contact Rtbrick customer support

Log ID	DHCPV6_BINDING_DELETED
Message	IPoE subscriber %s DHCPv6 lease expired
Description	Subscriber DHCPv6 binding deleted
Log Module	ipoe
Log Group	dhcp
Severity	info
Recommended Actions	Contact Rtbrick customer support

Log ID	DHCPV6_BINDING_EXPIRED
Message	IPoE subscriber %s DHCPv6 binding lease timer expired
Description	Subscriber DHCPv6 binding lease expired
Log Module	ipoe
Log Group	dhcp
Severity	info
Recommended Actions	Contact Rtbrick customer support

Log ID	DHCP_OPTION_IGNORED
Message	IPoE subscriber %s %s option %s ignored (%s)
Description	Subscriber DHCP option ignored
Log Module	ipoe
Log Group	dhcp
Severity	info
Recommended Actions	Contact Rtbrick customer support

Log ID	DHCP_BINDING_RELEASED
Message	IPoE subscriber %s DHCP binding released
Description	Subscriber DHCP binding released
Log Module	ipoe
Log Group	dhcp
Severity	info
Recommended Actions	Contact Rtbrick customer support

Log ID	DHCP_BINDING_FAILED
Message	IPoE subscriber %s DHCP binding failed
Description	Subscriber DHCP binding lease expired
Log Module	ipoe
Log Group	dhcp
Severity	info
Recommended Actions	Contact Rtbrick customer support

Log ID	DHCPV6_BINDING_RELEASED
Message	IPoE subscriber %s DHCPv6 binding released
Description	Subscriber DHCPv6 binding released
Log Module	ipoe
Log Group	dhcp
Severity	info
Recommended Actions	Contact Rtbrick customer support

Log ID	DHCPV6_BINDING_FAILED
Message	IPoE subscriber %s DHCPv6 binding failed
Description	Subscriber DHCPv6 binding failed
Log Module	ipoe
Log Group	dhcp
Severity	info
Recommended Actions	Contact Rtbrick customer support

Log ID	SUBSCRIBER_STATE
Message	IPoE subscriber %s state changed from %s to %s
Description	IPoE subscriber state
Log Module	ipoe
Log Group	subscriber
Severity	info
Recommended Actions	Contact Rtbrick customer support

Log ID	DHCPV6_IA_STATUS
Message	IPoE subscriber %s DHCPv6 %s from %s status code %s (%s)
Description	Subscriber DHCPv6 IA status code received
Log Module	ipoe
Log Group	dhcp
Severity	info
Recommended Actions	Contact Rtbrick customer support

Log ID	DHCP_RELAY_TRAP
Message	Trap rule %s %s for DHCP relay
Description	DHCP relay trap installation
Log Module	ipoe
Log Group	dhcp-relay
Severity	info
Recommended Actions	Contact Rtbrick customer support

Log ID	DHCP_RELAY_SHM_DECODE
Message	DHCP relay packet shm validation error
Description	Failed to decode received DHCP relay packet
Log Module	ipoe
Log Group	dhcp-relay
Severity	info
Recommended Actions	Contact Rtbrick customer support

Log ID	SUBSCRIBER_DELETE_FAILED
Message	IPoE subscriber %s deletion with terminate code %s failed
Description	IPoE subscriber deletion failed
Log Module	ipoe
Log Group	subscriber
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	SUBSCRIBER_RD_FAILURE
Message	IPoE subscriber %s from redundancy session %s failed due to %s
Description	IPoE redundancy subscriber failed
Log Module	ipoe
Log Group	redundancy
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	IPOED_BDS_TABLE_CREATE_ERROR
Message	Failed to create BDS table %s
Description	Failed to create BDS table
Log Module	ipoe
Log Group	general
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	DHCP_RELAY_DECODE_ERROR
Message	DHCP relay packet decode error on interface %s, error code: %s subcode: %s
Description	Failed to decode received DHCP relay packet
Log Module	ipoe
Log Group	dhcp-relay
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	DHCP_RELAY_IP_UDP_DECODE
Message	DHCP relay packet IP header decode error on interface %s
Description	Failed to decode received DHCP relay packet
Log Module	ipoe
Log Group	dhcp-relay
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	DHCP_RELAY_GATEWAY_IP
Message	DHCP relay gateway IP address not configured for interface %s
Description	DHCP relay config missing
Log Module	ipoe
Log Group	dhcp-relay
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	DHCP_RELAY_BINDING_ADD
Message	DHCP relay binding added for client %s on interface %s with gateway IP %s, client-ip %s and lease-time %s
Description	DHCP relay binding added
Log Module	ipoe
Log Group	dhcp-relay
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	DHCP_RELAY_BINDING_DELETE
Message	DHCP relay binding deleted for client %s on interface %s
Description	DHCP relay binding deleted
Log Module	ipoe
Log Group	dhcp-relay
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	DHCP_RELAY_BINDING_MISSING
Message	DHCP relay binding missing for client %s, ignoring the packet from server
Description	DHCP relay binding missing
Log Module	ipoe
Log Group	dhcp-relay
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	DHCP_RELAY_CONFIG
Message	DHCP relay configuration missing for interface %s
Description	DHCP relay config missing
Log Module	ipoe
Log Group	dhcp-relay
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	DHCP_RELAY_SERVER_LIST_CONFIG
Message	DHCP relay server configuration missing on interface %s, dropping the DHCP packet %s
Description	DHCP server config missing
Log Module	ipoe
Log Group	dhcp-relay
Severity	debug

Recommended Actions	Contact Rtbrick customer support

Log ID	DHCP_RELAY_SERVER_CONFIG
Message	DHCP relay server IP configuration missing on interface %s for DHCP server %s
Description	DHCP server config missing
Log Module	ipoe
Log Group	dhcp-relay
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	DHCP_RELAY_SERVER_GET
Message	Unable to get DHCP relay server %s configuration on interface %s
Description	DHCP server config missing
Log Module	ipoe
Log Group	dhcp-relay
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	DHCP_RELAY_PACKET_CLIENT_RCV
Message	DHCP %s received from client on interface %s with MAC %s
Description	DHCP relay packet received from client
Log Module	ipoe
Log Group	dhcp-relay

Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	DHCP_RELAY_PACKET_SERVER_RCV
Message	DHCP %s received from server %s for client on interface %s with MAC %s
Description	DHCP relay packet received from server
Log Module	ipoe
Log Group	dhcp-relay
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	DHCP_RELAY_PACKET_CLIENT_SENT
Message	DHCP %s from server %s sent to client on interface %s with MAC %s
Description	DHCP relay packet sent to client
Log Module	ipoe
Log Group	dhcp-relay
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	DHCP_RELAY_PACKET_SERVER_SENT
Message	DHCP %s sent to server %s from client on interface %s with MAC %s
Description	DHCP relay packet sent to server

Log Module	ipoe
Log Group	dhcp-relay
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	DHCP_RELAY_PACKET_CLIENT_RCV_INVALID
Message	Invalid DHCP %s received from client on interface %s with MAC %s
Description	DHCP relay packet received from client
Log Module	ipoe
Log Group	dhcp-relay
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	DHCP_RELAY_PACKET_SERVER_RCV_INVALID
Message	Invalid DHCP %s received from server %s
Description	DHCP relay packet received from server
Log Module	ipoe
Log Group	dhcp-relay
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	DHCP_RELAY_PROXY_SERVER
Message	Selecting the server %s for the client on interface %s in proxy mode

Description	DHCP relay proxy server selected
Log Module	ipoe
Log Group	dhcp-relay
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	DHCP_RELAY_PROXY_IGNORE_SERVER_PACKET
Message	Ignoring packet %s from server %s as the selected server is %s
Description	DHCP relay proxy packet ignored from server
Log Module	ipoe
Log Group	dhcp-relay
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	DHCP_RELAY_ENCODE_ERROR
Message	Error in encoding DHCP %s packet with client interface %s with MAC %s
Description	DHCP relay encode error
Log Module	ipoe
Log Group	dhcp-relay
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	DHCP_RELAY_PROXY_NO_SERVER

Message	Server identifier missing in DHCP relay binding, dropping the DHCP %s packet from client interface %s with MAC %s
Description	DHCP relay proxy no server in binding
Log Module	ipoe
Log Group	dhcp-relay
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	DHCP_RELAY_INVALID_DST_IP
Message	Invalid destination IP, dropping the DHCP %s packet from client interface %s with MAC %s
Description	DHCP relay proxy no server in binding
Log Module	ipoe
Log Group	dhcp-relay
Severity	debug
Recommended Actions	Contact Rtbrick customer support

IS-IS Log Messages

Log Level Summary

Alert(1), Info(14), Debug(4)

Log ID	ISIS_AUTHENTICATION_FAIL
Message	Authentication failure for PDU %s, interface %s, instance %s, level %s
Description	ISIS Authentication failure log
Log Module	isis

Log Group	message
Severity	alert
Recommended Actions	Contact Rtbrick customer support

Log ID	ISIS_INSTANCE_OVERLOAD
Message	ISIS instance %s, level %s, %s, overload state
Description	ISIS instance overload enter/exit log
Log Module	isis
Log Group	instance
Severity	info
Recommended Actions	Contact Rtbrick customer support

Log ID	ISIS_NEIGHBOR_DISCOVERY
Message	ISIS neighbor %s, discovered, interface %s, instance %s
Description	ISIS neighbor discovery log
Log Module	isis
Log Group	neighbor
Severity	info
Recommended Actions	Contact Rtbrick customer support

Log ID	ISIS_NEIGHBOR_STATE_CHANGE
Message	ISIS neighbor %s, interface %s, instance %s, changed state from %s, to %s, reason %s
Description	ISIS neighbor FSM state change log

Log Module	isis
Log Group	neighbor
Severity	info
Recommended Actions	Contact Rtbrick customer support

Log ID	ISIS_IFL_CHANGE
Message	Interface %s, instance %s, received event %s, operational state %s, admin state %s, ipv4 status %s, ipv6 status %s
Description	ISIS enabled interface status change event
Log Module	isis
Log Group	interface
Severity	info
Recommended Actions	Contact Rtbrick customer support

Log ID	ISIS_IFA_CHANGE
Message	Interface %s, instance %s, received %s, for address %s
Description	ISIS enabled interface address event
Log Module	isis
Log Group	interface
Severity	info
Recommended Actions	Contact Rtbrick customer support

Log ID	ISIS_PDU_DECODE_FAIL
Message	ISIS PDU %s, decode failure received in interface %s, instance %s, level %s, reason %s

Description	ISIS PDU decode failure log
Log Module	isis
Log Group	message
Severity	info
Recommended Actions	Contact Rtbrick customer support

Log ID	ISIS_LSP_FLOOD_FILTER_BLOCK
Message	LSP flooding is blocked for neighbor %s, in interface %s, instance %s, level %s, for lsp-id %s
Description	ISIS flood filter block log
Log Module	isis
Log Group	message
Severity	info
Recommended Actions	Contact Rtbrick customer support

Log ID	ISIS_SPF_COMPUTATION
Message	Dijkstra’s Shortest Path First algorithm triggered in instance %s, level %s. Reason %s
Description	Dijkstra’s Shortest Path First algorithm triggered
Log Module	isis
Log Group	spf
Severity	Info
Recommended Actions	Contact Rtbrick customer support

Log ID	ISIS_SPF_COMPUTATION_LSP

Message	Dijkstra’s Shortest Path First algorithm triggered in instance %s, level %s. Reason LSP %s, received
Description	LSP received triggers Dijkstra’s Shortest Path First algorithm
Log Module	isis
Log Group	spf
Severity	info
Recommended Actions	Contact Rtbrick customer support

Log ID	ISIS_ORIGINATE_SELF_LSP
Message	Self lsp is originate in instance %s, level %s, lsp id %s, sequence number %s
Description	Self lsp origination log
Log Module	isis
Log Group	lsp
Severity	info
Recommended Actions	Contact Rtbrick customer support

Log ID	ISIS_IPV4_PREFIX_ADD
Message	Add %s, metric %s, source %s, preference %s, instance %s, topology %s
Description	ipv4 prefix addition log
Log Module	isis
Log Group	route
Severity	info
Recommended Actions	Contact Rtbrick customer support

Log ID	ISIS_IPV6_PREFIX_ADD
Message	Add %s, metric %s, source %s, preference %s, instance %s, topology %s
Description	ipv6 prefix addition log
Log Module	isis
Log Group	route
Severity	info
Recommended Actions	Contact Rtbrick customer support

Log ID	ISIS_MPLS_LABEL_ADD
Message	Add mpls label %s, source %s, preference %s, instance %s, topology %s
Description	MPLS prefix addition log
Log Module	isis
Log Group	route
Severity	info
Recommended Actions	Contact Rtbrick customer support

Log ID	ISIS_MPLS_LABEL_DELETE
Message	Delete mpls-label %s, instance %s, topology %s
Description	MPLS prefix deletion log
Log Module	isis
Log Group	route
Severity	info
Recommended Actions	Contact Rtbrick customer support

Log ID	ISIS_NEIGHBOR_DELETED
Message	ISIS neighbor %s, deleted, interface %s, instance %s
Description	ISIS neighbor deleted log
Log Module	isis
Log Group	neighbor
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	ISIS_ORIGINATE_LSP_PURGE
Message	Purge lsp is originated in instance %s, level %s, lsp id %s, sequence number %s
Description	Purge lsp origination log
Log Module	isis
Log Group	lsp
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	ISIS_IPV4_PREFIX_DELETE
Message	Delete %s, instance %s, topology %s
Description	ipv4 prefix deletion log
Log Module	isis
Log Group	route
Severity	Debug
Recommended Actions	Contact Rtbrick customer support

Log ID	ISIS_IPV6_PREFIX_DELETE
Message	Delete %s, instance %s, topology %s
Description	ipv6 prefix deletion log
Log Module	isis
Log Group	route
Severity	Debug
Recommended Actions	Contact Rtbrick customer support

LDP Log Messages

Log Level Summary

Info(5), Debug(18)

Log ID	LDP_NBR_CREATED
Message	LDP Neighbour created, peer %s, interface %s, instance %s
Description	LDP has formed a new neighbor
Log Module	ldp
Log Group	adjacency
Severity	INFO
Recommended Actions	None Required.

Log ID	LDP_NBR_DELETED
Message	LDP Neighbour deleted, peer %s, interface %s, instance %s
Description	LDP neighbor is removed.
Log Module	ldp

Log Group	adjacency
Severity	INFO
Recommended Actions	Configure the neighbor router again for establishing neighborship and sending hello packets.

Log ID	LDP_NOTIFICATION_IN
Message	LDP Notification received, peer %s, instance %s, reason %s
Description	LDP has received notification messages. There are basically two types of notification, one is advisory and the other is fatal. In case a fatal notification is received, the session will be reset.
Log Module	ldp
Log Group	notification
Severity	INFO
Recommended Actions	If the peer is reset, run the show ldp session detail command and check the “Reason” attribute.

Log ID	LDP_NOTIFICATION_OUT
Message	LDP Notification sent, peer %s, instance %s, reason %s
Description	LDP has sent out notification messages to the peer.
Log Module	ldp
Log Group	notification
Severity	INFO
Recommended Actions	If peer is reset, run the show ldp session detail command and check the “Reason” attribute.

Log ID	LDP_SESSION_STATE
Message	LDP session state changed to %s, peer %s, instance %s

Description	LDP session state has changed
Log Module	ldp
Log Group	peer
Severity	INFO
Recommended Actions	None Required.

Log ID	LDP_SESSION_CREATED
Message	LDP Session created, peer %s, instance %s
Description	LDP has formed a new session.
Log Module	ldp
Log Group	peer
Severity	debug
Recommended Actions	None Required.

Log ID	LDP_SESSION_DELETED
Message	LDP Session deleted, peer %s, instance %s
Description	LDP session is deleted.
Log Module	ldp
Log Group	peer
Severity	debug
Recommended Actions	Run the show ldp session detail command and check the “Reason” attribute for information.

Log ID	LDP_TCP_STATE_CHNG

Message	LDP TCP state changed from "%s" to "%s" due to event "%s", peer %s, instance %s
Description	LDP TCP state has changed.
Log Module	ldp
Log Group	peer
Severity	debug
Recommended Actions	None Required.

Log ID	LDP_SESSION_STATE_CHNG
Message	LDP Session state changed from "%s" to "%s" due to event "%s", peer %s, instance %s
Description	LDP session state has changed.
Log Module	ldp
Log Group	peer
Severity	debug
Recommended Actions	None Required.

Log ID	LDP_MSG_ADDR_OUT
Message	LDP Address message sent for prefix %s, peer %s, instance %s
Description	LDP address message is sent.
Log Module	ldp
Log Group	peer
Severity	debug
Recommended Actions	None Required.

Log ID	LDP_MSG_ADDR_IN
Message	LDP Address message received for prefix %s, peer %s, instance %s
Description	LDP address message is received.
Log Module	ldp
Log Group	peer
Severity	debug
Recommended Actions	None Required.

Log ID	LDP_MSG_ADDR_WITHDRAW_OUT
Message	LDP Address withdraw message sent for prefix %s, peer %s, instance %s
Description	LDP address withdrawal message is sent.
Log Module	ldp
Log Group	peer
Severity	debug
Recommended Actions	None Required.

Log ID	LDP_MSG_ADDR_WITHDRAW_IN
Message	LDP Address withdraw message received for prefix %s, peer %s, instance %s
Description	LDP address withdrawal message is received.
Log Module	ldp
Log Group	peer
Severity	debug
Recommended Actions	None Required.

Log ID	LDP_MSG_LABEL_MAP_OUT
Message	LDP label mapping message sent for prefix %s with label-%s, peer %s, instance %s
Description	LDP mapping message is sent.
Log Module	ldp
Log Group	peer
Severity	debug
Recommended Actions	None Required.

Log ID	LDP_MSG_LABEL_MAP_IN
Message	LDP label mapping message received for prefix %s with label-%s, peer %s, instance %s
Description	LDP mapping is received.
Log Module	ldp
Log Group	peer
Severity	debug
Recommended Actions	None Required.

Log ID	LDP_MSG_LABEL_WITHDRAW_OUT
Message	LDP label withdraw message sent for prefix %s with label-%s, peer %s, instance %s
Description	LDP mapping withdrawal message is sent.
Log Module	ldp
Log Group	peer
Severity	debug

Recommended Actions	None Required.

Log ID	LDP_MSG_LABEL_WITHDRAW_IN
Message	LDP label withdraw message received for prefix %s with label-%s, peer %s, instance %s
Description	LDP mapping withdrawal message is received.
Log Module	ldp
Log Group	peer
Severity	debug
Recommended Actions	None Required.

Log ID	LDP_MSG_LABEL_REQ_REPLY_OUT
Message	LDP label request message reply for prefix %s sent with label-%s, peer %s, instance %s
Description	LDP request reply message is sent.
Log Module	ldp
Log Group	peer
Severity	debug
Recommended Actions	None Required.

Log ID	LDP_MSG_LABEL_REQ_IN
Message	LDP label request message received, prefix %s, peer %s, instance %s
Description	LDP request message is received.
Log Module	ldp

Log Group	peer
Severity	debug
Recommended Actions	None Required.

Log ID	LDP_MSG_LABEL_REL_OUT
Message	LDP label release message sent, prefix %s, label-%s, peer %s, instance %s
Description	LDP release message is sent.
Log Module	ldp
Log Group	peer
Severity	debug
Recommended Actions	None Required.

Log ID	LDP_MSG_LABEL_REL_IN
Message	LDP label release message received, prefix %s, label-%s, peer %s, instance %s
Description	LDP release message is received.
Log Module	ldp
Log Group	peer
Severity	debug
Recommended Actions	None Required.

Log ID	LDP_ADD_TO_FIB
Message	LDP route added to FIB, prefix %s, label-%s, instance %s
Description	LDP has been added to FIB.

Log Module	ldp
Log Group	peer
Severity	debug
Recommended Actions	None Required.

Log ID	LDP_DEL_FROM_FIB
Message	LDP route deleted from FIB, prefix %s, label-%s, instance %s
Description	LDP is deleted from FIB.
Log Module	ldp
Log Group	peer
Severity	debug
Recommended Actions	None Required.

License Log Messages

Log Level Summary

Critical(4), Error(16), Warning(1), Notice(1), Info(2)

Log ID	LICENSE_TRAIL_PERIOD_EXPIRY
Message	The software trial period has ended, please install a license
Description	The software trial period has ended, please install a license
Log Module	license
Log Group	operational
Severity	CRITICAL
Recommended Actions	Please install a license

Log ID	LICENSE_EXPIRY_CRITICAL
Message	The current license has expired, please install a new license
Description	The current license has expired
Log Module	license
Log Group	operational
Severity	CRITICAL
Recommended Actions	Please install a new license

Log ID	LICENSE_INSTALL_FAIL
Message	License installation failed. Please try again. If its persists contact support
Description	The license has not been installed
Log Module	license
Log Group	operational
Severity	CRITICAL
Recommended Actions	Please contact RtBrick support

Log ID	LICENSE_EXPIRED_INSTALL
Message	License installed has already expired, please install a valid license
Description	The current license has expired
Log Module	license
Log Group	operational
Severity	CRITICAL
Recommended Actions	Please install a new license

Log ID	LICENSE_INTERNAL_NULL_STRING
Message	NULL license string passed to license verification API
Description	Invalid parameters passed for license verification API
Log Module	license
Log Group	internal
Severity	ERROR
Recommended Actions	Internal error, please contact Rtbrick Customer Support

Log ID	LICENSE_FILE_READ_FAILURE
Message	Unable to read license string from license file %s
Description	License file read failed
Log Module	license
Log Group	internal
Severity	ERROR
Recommended Actions	Internal error, please contact Rtbrick Customer Support

Log ID	LICENSE_FILE_OPEN_FAILURE
Message	Unable to open from license file %s
Description	Unable to open license file
Log Module	license
Log Group	internal
Severity	ERROR
Recommended Actions	Internal error, please contact Rtbrick Customer Support

Log ID	LICENSE_STRING_ALLOCATION_FAILURE
Message	Unable to allocate %s bytes for license string
Description	Memory allocation failure
Log Module	license
Log Group	internal
Severity	ERROR
Recommended Actions	Internal error, please contact Rtbrick Customer Support

Log ID	LICENSE_INVALID_STRING_IN_FILE
Message	Invalid license string present in license file %s
Description	Invalid license installed
Log Module	license
Log Group	internal
Severity	ERROR
Recommended Actions	Internal error, please contact Rtbrick Customer Support

Log ID	LICENSE_INVALID_CONTENT
Message	Invalid license content in file %s
Description	Invalid license content
Log Module	license
Log Group	internal
Severity	ERROR
Recommended Actions	Internal error, please contact Rtbrick Customer Support

Log ID	LICENSE_DIRECTORY_OPEN_FAILURE
Message	Unable to open license directory
Description	License directory open failure
Log Module	license
Log Group	internal
Severity	ERROR
Recommended Actions	Internal error, please contact Rtbrick Customer Support

Log ID	LICENSE_START_DATE_MISSING
Message	License doesn’t have a start date
Description	License doesn’t have a start date
Log Module	license
Log Group	internal
Severity	ERROR
Recommended Actions	Start date missing in licence please ask for a new license

Log ID	LICENSE_END_DATE_MISSING
Message	License doesn’t have a end date
Description	License doesn’t have a end date
Log Module	license
Log Group	internal
Severity	ERROR
Recommended Actions	End date missing in license please ask for a new license

Log ID	LICENSE_DIRECTORY_CLOSE_FAILURE
Message	Unable to close license directory
Description	Unable to close license directory
Log Module	license
Log Group	internal
Severity	ERROR
Recommended Actions	Internal error, please contact Rtbrick Customer Support

Log ID	LICENSE_INIT_FAILED
Message	License initialization failed
Description	License initialization failed
Log Module	license
Log Group	internal
Severity	ERROR
Recommended Actions	Internal error, please contact Rtbrick Customer Support

Log ID	LICENSE_TABLE_NOT_PRESENT
Message	License table (global.rtbrick.license) is not present
Description	License table (global.rtbrick.license) is not present
Log Module	license
Log Group	internal
Severity	ERROR
Recommended Actions	Internal error, please contact Rtbrick Customer Support

Log ID	LICENSE_SECONDARY_VALIDATION_COMPROMISED
Message	License table (global.rtbrick.license) is not present
Description	License table (global.rtbrick.license) is not present
Log Module	license
Log Group	internal
Severity	ERROR
Recommended Actions	Internal error, please contact Rtbrick Customer Support

Log ID	LICENSE_QUOTA_TABLE_CREATE_FAILED
Message	License quota table (secure.license.quota) is not present
Description	License quota table (secure.license.quota) is not present
Log Module	license
Log Group	internal
Severity	ERROR
Recommended Actions	Internal error, please contact Rtbrick Customer Support

Log ID	LICENSE_CONFIG_TABLE_CREATE_FAILED
Message	License config table (local.rtbrick.license.config) is not present
Description	License config table (local.rtbrick.license.config) is not present
Log Module	license
Log Group	internal
Severity	ERROR

Recommended Actions	Internal error, please contact Rtbrick Customer Support

Log ID	LICENSE_EXPIRY_ERROR
Message	The current license will expire today, please install a new license
Description	The current license about to expire
Log Module	license
Log Group	operational
Severity	ERROR
Recommended Actions	Please install a new license

Log ID	LICENSE_EXPIRY_WARNING
Message	The current license will expire in %s day(s), please install a new license
Description	The current license about to expire
Log Module	license
Log Group	operational
Severity	WARNING
Recommended Actions	Please install a new license

Log ID	LICENSE_INSTALL_SUCCESSFUL
Message	Valid license has been successfully installed
Description	License active
Log Module	license
Log Group	operational

Severity	NOTICE
Recommended Actions	Device is up for operation

Log ID	LICENSE_INTERNAL_INVALID_STRING
Message	Invalid license string passed to license verification API
Description	Invalid parameters passed for license verification API
Log Module	license
Log Group	internal
Severity	INFO
Recommended Actions	Internal error, please contact Rtbrick Customer Support

Log ID	LICENSE_HOSTCONFD_CONNECTION_DOWN
Message	License installation delayed due to hostconfd connection down
Description	License installation delayed due to hostconfd connection down
Log Module	license
Log Group	internal
Severity	INFO
Recommended Actions	Internal error, please contact Rtbrick Customer Support

Policy Log Messages

Log Level Summary

Error(3), Warning(1), Info(3)

Log ID	POLICY_LOG_CODE_GEN_ERROR
Message	Policy [%s] Term [%s] Match Type [%s] List [%s] Command [%s] Ordinal [%s], SubOrdinal [%s] : Error [%s]
Description	Generation Policy errors
Log Module	policy
Log Group	Generation
Severity	ERROR
Recommended Actions	Contact Rtbrick customer support

Log ID	POLICY_LOG_CODE_GEN_STATUS_FAILED
Message	Policy [%s]: Code Generation Error Reason [%s]
Description	Generation Policy Error Reason
Log Module	policy
Log Group	Generation
Severity	ERROR
Recommended Actions	Contact Rtbrick customer support

Log ID	POLICY_LOG_BDS_ERROR
Message	Policy [%s]: Error [%s]
Description	Policy & BDS API interaction errors
Log Module	policy
Log Group	BDS
Severity	ERROR
Recommended Actions	Contact Rtbrick customer support

Log ID	POLICY_LOG_CONFIG_PROC_WARNING
Message	Policy [%s]: Warning [%s]
Description	Policy Configuration processing warnings
Log Module	policy
Log Group	Configuration
Severity	WARNING
Recommended Actions	Contact Rtbrick customer support

Log ID	POLICY_LOG_CODE_GEN_EVENTS
Message	Policy [%s] Term [%s] Match Type [%s] List [%s] Command [%s] Ordinal [%s], SubOrdinal [%s] : Event [%s]
Description	Generation Policy Events
Log Module	policy
Log Group	Generation
Severity	INFO
Recommended Actions	Contact Rtbrick customer support

Log ID	POLICY_LOG_CODE_GEN_STATUS_SUCCESS
Message	Policy [%s]: Code Generation Status: [%s]
Description	Generation Policy Status
Log Module	policy
Log Group	Generation
Severity	INFO
Recommended Actions	Contact Rtbrick customer support

Log ID	POLICY_LOG_CODE_GEN_NOTIFICATION
Message	Policy [%s]: Notification Status [%s]
Description	Generation Policy Notification
Log Module	policy
Log Group	Generation
Severity	INFO
Recommended Actions	Contact Rtbrick customer support

PPPoE Log Messages

Log Level Summary

Notice(1), Info(35), Debug(21)

Log ID	PPPOE_SESSION_LIMIT_REACHED
Message	PPPoE session limit reached on interface %s, MAC %s, S-Tag %s, C-Tag %s
Description	PPPoE session limit reached
Log Module	pppoe
Log Group	pppoe
Severity	notice
Recommended Actions	New session can be created only after removing existing sessions

Log ID	PPPOE_CONFIG_NOT_FOUND
Message	No matching configuration found for PPPoE discovery on interface %s, MAC %s, S-Tag %s, C-Tag %s
Description	Received PPPoE discovery packet without matching configuration

Log Module	pppoe
Log Group	config
Severity	info
Recommended Actions	Contact Rtbrick customer support

Log ID	PPPOE_SUBSCRIBER_ID_GET_FAILED
Message	PPPoE session subscriber-id get failed on interface %s, MAC %s, PPPoE session-id %s, S-Tag %s, C-Tag %s
Description	Failed to assign subscriber identifier to PPPoE session
Log Module	pppoe
Log Group	subscriber
Severity	info
Recommended Actions	Contact Rtbrick customer support

Log ID	PPPOE_FSM_STATE_CHANGE
Message	%s session for subscriber-id %s changed state from %s to %s for input %s, action %s
Description	PPP FSM state changed
Log Module	pppoe
Log Group	ppp
Severity	info
Recommended Actions	Contact Rtbrick customer support

Log ID	PPPOE_PPP_SEND_ERROR

Message	Failed to encode and send PPP packet on interface %s, subscriber-id %s
Description	Failed to encode and send PPP packet
Log Module	pppoe
Log Group	ppp
Severity	info
Recommended Actions	Contact Rtbrick customer support

Log ID	PPPOE_LCP_WRONG_ECHO_MAGIC
Message	LCP ECHO received on interface %s, subscriber-id %s with wrong magic number %s, expected %s
Description	PPP LCP echo request/reply received with wrong magic number
Log Module	pppoe
Log Group	ppp
Severity	info
Recommended Actions	Check the magic number

Log ID	PPPOE_LCP_WRONG_ECHO_REPLY_ID
Message	LCP ECHO reply received on interface %s, subscriber-id %s with wrong identifier %s, expected %s
Description	PPP LCP echo reply received with wrong identifier
Log Module	pppoe
Log Group	ppp
Severity	info
Recommended Actions	Check LCP packet identifier

Log ID	PPPOE_LCP_RCV_PROTO_REJECT
Message	PPP protocol reject received on interface %s, subscriber-id %s protocol %s
Description	PPP protocol reject received
Log Module	pppoe
Log Group	ppp
Severity	info
Recommended Actions	Contact Rtbrick customer support

Log ID	PPPOE_PROTO_DECODE_ERROR
Message	%s packet decode error on interface %s, MAC %s, session-id %s, subscriber-id %s with remaining packet length %s
Description	Failed to decode received PPPoE PPP packet
Log Module	pppoe
Log Group	ppp
Severity	info
Recommended Actions	Contact Rtbrick customer support

Log ID	PPPOE_LCP_RCV_WRONG_ID
Message	LCP %s received on interface %s, subscriber-id %s with identifier %s, expected %s
Description	PPP LCP response with wrong identifer received
Log Module	pppoe
Log Group	ppp
Severity	info

Recommended Actions	Contact Rtbrick customer support

Log ID	PPPOE_LCP_RCV_MRU
Message	LCP %s received on interface %s, subscriber-id %s with received MRU %s, local MRU %s
Description	PPP LCP response with wrong or suggested MRU received
Log Module	pppoe
Log Group	ppp
Severity	info
Recommended Actions	Contact Rtbrick customer support

Log ID	PPPOE_LCP_RCV_MAGIC
Message	LCP %s received on interface %s, subscriber-id %s with received magic %s, local magic %s
Description	PPP LCP response with wrong or suggested magic number received
Log Module	pppoe
Log Group	ppp
Severity	info
Recommended Actions	Contact Rtbrick customer support

Log ID	PPPOE_LCP_RCV_AUTH
Message	LCP %s received on interface %s, subscriber-id %s with wrong authentication protocol %s, expected %s

Description	PPP LCP response with wrong or suggested auth protocol received
Log Module	pppoe
Log Group	ppp
Severity	info
Recommended Actions	Contact Rtbrick customer support

Log ID	PPPOE_PPP_RCV_ERROR
Message	%s receive error %s on interface %s, MAC %s, session-id %s, subscriber-id %s
Description	PPP receive errors
Log Module	pppoe
Log Group	ppp
Severity	info
Recommended Actions	Contact Rtbrick customer support

Log ID	PPPOE_PROTO_MAX_RETRANSMISSION
Message	Maximum %s retransmission count on interface %s, subscriber-id %s, retransmit count %s
Description	PPPoE PPP retransmission exceeded
Log Module	pppoe
Log Group	ppp
Severity	info
Recommended Actions	Contact Rtbrick customer support

Log ID	PPPOE_AUTH_REJECT
Message	Authentication rejected on interface %s, subscriber-id %s with user %s
Description	PPPoE PPP authentication rejected
Log Module	pppoe
Log Group	ppp
Severity	info
Recommended Actions	Contact Rtbrick customer support

Log ID	PPPOE_NO_SOURCE_IP
Message	%s source IP address not found on interface %s, subscriber-id %s
Description	Missing source IP address to setup PPPoE PPP session
Log Module	pppoe
Log Group	ppp
Severity	info
Recommended Actions	Contact Rtbrick customer support

Log ID	PPPOE_PROTO_RECEIVE_ERROR
Message	Protocol receive error %s on interface %s, MAC %s, session-id %s, subscriber-id %s
Description	PPPoE PPP protocol receive error
Log Module	pppoe
Log Group	ppp
Severity	info
Recommended Actions	Contact Rtbrick customer support

Log ID	PPPOE_PROTO_RCV_ID_WARNING
Message	%s %s received on interface %s, subscriber-id %s with wrong identifier %s, expected %s
Description	PPP NCP reply received with wrong identifier
Log Module	pppoe
Log Group	ppp
Severity	info
Recommended Actions	Contact Rtbrick customer support

Log ID	PPPOE_IPCP_RECEIVE_WRONG_IP
Message	IPCP %s received on interface %s, subscriber-id %s with address %s, expected %s
Description	PPP IPCP reply received with wrong address
Log Module	pppoe
Log Group	ppp
Severity	info
Recommended Actions	Check the IP address configured in the client

Log ID	PPPOE_IPV6_CHECKSUM_ERROR
Message	PPPoE IPv6 packet decode checksum error on interface %s, subscriber-id %s
Description	Failed to decode received PPPoE PPP packet with wrong IPv6 checksum (UDP or ICMPv6)
Log Module	pppoe
Log Group	ppp
Severity	info

Recommended Actions	Contact Rtbrick customer support

Log ID	PPPOE_DECODE_ERROR
Message	Error decoding received PPPoE packet on interface %s, MAC %s
Description	Failed to decode PPPoE ethertype or VLAN
Log Module	pppoe
Log Group	pppoe
Severity	info
Recommended Actions	Contact Rtbrick customer support

Log ID	PPPOE_DECODE_ERROR_WITH_VLAN
Message	Error decoding received PPPoE packet on interface %s, MAC %s, S-Tag %s, C-Tag %s
Description	Failed to decode PPPoE discovery packet
Log Module	pppoe
Log Group	pppoe
Severity	info
Recommended Actions	Contact Rtbrick customer support

Log ID	PPPOE_UNKNOWN_DISCOVERY_PACKET
Message	Received unknown PPPoE discovery packet on interface %s, MAC %s, S-Tag %s, C-Tag %s, session-id %s
Description	Received unknown PPPoE discovery packet
Log Module	pppoe

Log Group	pppoe
Severity	info
Recommended Actions	Contact Rtbrick customer support

Log ID	PPPOE_SESSION_CREATE
Message	PPPoE session created on interface %s, S-Tag %s, C-Tag %s, MAC %s, PPPoE session-id %s, subscriber-id %s, state %s access-profile %s
Description	Create of PPPoE/PPP session after PADS is sent
Log Module	pppoe
Log Group	pppoe
Severity	info
Recommended Actions	Contact Rtbrick customer support

Log ID	PPPOE_PACKET_ENCODE_ERROR
Message	Could not encode PPPoE %s on interface %s, MAC %s, PPPoE session-id %s, S-Tag %s, C-Tag %s
Description	PPPoE discovery encode error
Log Module	pppoe
Log Group	pppoe
Severity	info
Recommended Actions	Contact Rtbrick customer support

Log ID	PPPOE_BAD_PACKET_INTERFACE_GET_FAILED

Message	Interface get failed for PPPoE %s packet on interface %s, MAC %s
Description	PPPoE discovery packet received on invalid interface
Log Module	pppoe
Log Group	pppoe
Severity	info
Recommended Actions	Contact Rtbrick customer support

Log ID	PPPOE_BAD_PACKET_INTERFACE_DOWN
Message	Received PPPoE %s packet on operationaly down interface %s, MAC %s
Description	PPPoE discovery packet received on down interface
Log Module	pppoe
Log Group	pppoe
Severity	info
Recommended Actions	Contact Rtbrick customer support

Log ID	PPPOE_BAD_PACKET_WRONG_MAC
Message	Received bad PPPoE %s packet with wrong MAC on interface %s, MAC %s
Description	Invalid PPPoE discovery packet received with wrong MAC
Log Module	pppoe
Log Group	pppoe
Severity	info
Recommended Actions	Contact Rtbrick customer support

Log ID	PPPOE_BAD_PACKET_NO_AC_COOKIE
Message	Received bad PPPoE %s packet on interface %s, MAC %s with no ac cookie
Description	Invalid PPPoE discovery packet received with no ac_cookie
Log Module	pppoe
Log Group	pppoe
Severity	info
Recommended Actions	Contact Rtbrick customer support

Log ID	PPPOE_BAD_PACKET_WRONG_AC_COOKIE
Message	Received bad PPPoE %s packet on interface %s, MAC %s with wrong ac cookie
Description	Invalid PPPoE discovery packet received with wrong ac_cookie
Log Module	pppoe
Log Group	pppoe
Severity	info
Recommended Actions	Contact Rtbrick customer support

Log ID	PPPOE_BAD_PACKET_UNKNOWN_ETHER_TYPE
Message	Received bad PPPoE packet on interface %s, MAC %s with unknown ether type %s
Description	Received PPPoE discovery packet with invalid ethertype
Log Module	pppoe
Log Group	pppoe
Severity	info

Recommended Actions	Contact Rtbrick customer support

Log ID	PPPOE_SESSION_DELETE
Message	PPPoE session delete on interface %s, MAC %s, PPPoE session-id %s, S-Tag %s, C-Tag %s
Description	PPPoE session delete
Log Module	pppoe
Log Group	pppoe
Severity	info
Recommended Actions	Contact Rtbrick customer support

Log ID	PPPOE_DHCPV6_DECODE_ERROR
Message	PPPoE DHCPv6 packet decode error on interface %s, subscriber-id %s error code: %s subcode: %s
Description	Failed to decode received PPPoE DHCPv6 packet
Log Module	pppoe
Log Group	dhcpv6
Severity	info
Recommended Actions	Contact Rtbrick customer support

Log ID	PPPOE_DHCPV6_VALIDATION_ERROR
Message	PPPoE DHCPv6 packet validation error on interface %s, subscriber-id %s
Description	Failed to validate received PPPoE DHCPv6 packet
Log Module	pppoe

Log Group	dhcpv6
Severity	info
Recommended Actions	Contact Rtbrick customer support

Log ID	PPPOE_VENDOR_REQUEST_FAILED
Message	LCP vendor request failed for subscriber-id %s, %s
Description	PPPoE PPP LCP vendor request failed
Log Module	pppoe
Log Group	ppp
Severity	info
Recommended Actions	Contact Rtbrick customer support

Log ID	PPPOE_RECEIVE_ERROR
Message	PPPOE packet receive with %s
Description	Generic PPPoE receive error
Log Module	pppoe
Log Group	general
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	PPPOE_CONFIG_FOUND
Message	PPPoE %s received on interface %s, MAC %s, S-Tag %s, C-Tag %s, found access-profile %s
Description	Received PPPoE discovery packet with matching configuration

Log Module	pppoe
Log Group	config
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	PPPOE_SUBSCRIBER_IN
Message	Result from subscriberd for subscriber-id %s with action %s
Description	Action received from subscriberd
Log Module	pppoe
Log Group	subscriber
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	PPPOE_LCP_SESSION_EVENT
Message	LCP session %s on interface %s, MAC %s, PPPoE session-id %s, subscriber-id %s
Description	PPP LCP protocol events
Log Module	pppoe
Log Group	ppp
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	PPPOE_IPCP_SESSION_EVENT
Message	IPCP session %s on interface %s, MAC %s, PPPoE session-id %s, subscriber-id %s

Description	PPP IPCP protocol events
Log Module	pppoe
Log Group	ppp
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	PPPOE_IP6CP_SESSION_EVENT
Message	IP6CP session %s on interface %s, MAC %s, PPPoE session-id %s, subscriber-id %s
Description	PPP IP6CP protocol events
Log Module	pppoe
Log Group	ppp
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	PPPOE_LCP_PRINT_MY_OPTIONS
Message	PPP LCP options for subscriber-id %s, MRU %s, magic %s, authentication %s, identifier %s, retransmission-count %s, retransmisson-interval %s
Description	Local PPP LCP options
Log Module	pppoe
Log Group	ppp
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	PPPOE_LCP_START_ECHO
Message	LCP start echo on interface %s, subscriber-id %s
Description	Start sending PPP LCP echo request interval
Log Module	pppoe
Log Group	ppp
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	PPPOE_LCP_RCV_CONFX
Message	PPP LCP %s received on interface %s, subscriber-id %s, MRU %s, magic %s, authentication %s
Description	PPP LCP request/response received
Log Module	pppoe
Log Group	ppp
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	PPPOE_LCP_NEGOTIATION
Message	LCP %s on interface %s for subscriber-id %s
Description	PPP LCP negotiation
Log Module	pppoe
Log Group	ppp
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	PPPOE_LCP_SETUP
Message	LCP setup %s on interface %s for subscriber-id %s
Description	PPPoE PPP sessions setup
Log Module	pppoe
Log Group	ppp
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	PPPOE_AUTH_RCV_REQ
Message	%s receive request packet on interface %s, subscriber-id %s, user %s
Description	PPPoE PPP authentication request received
Log Module	pppoe
Log Group	ppp
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	PPPOE_LCP_UPPPER_LAYER_TEARDOWN
Message	LCP teardown by upper layer on interface %s for subscriber-id %s
Description	PPPoE PPP session teardown/termination
Log Module	pppoe
Log Group	ppp
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	PPPOE_NCP_SESSION_DETAIL
Message	%s session on interface %s, subscriber-id %s, retransmission-interval %s, local ipv4 address %s
Description	PPPoE PPP NCP local session info
Log Module	pppoe
Log Group	ppp
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	PPPOE_IPCP_CONFREQ_PEER
Message	IPCP CONFREQ peer info for subscriber-id %s on interface %s, peer ipv4-address %s, primary dns %s, secondary dns %s
Description	PPPoE PPP IPCP session info
Log Module	pppoe
Log Group	ppp
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	PPPOE_IPCP_CONFREQ
Message	IPCP CONFREQ received for subscriber-id %s on interface %s, peer ipv4-address %s, primary dns %s, secondary dns %s
Description	PPPoE PPP IPCP received
Log Module	pppoe
Log Group	ppp
Severity	debug

Recommended Actions	Contact Rtbrick customer support

Log ID	PPPOE_DISCOVERY_PACKET_RECEIVE
Message	Received PPPoE %s packet on interface %s, MAC %s, session-id %s
Description	Received PPPoE discovery packet
Log Module	pppoe
Log Group	pppoe
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	PPPOE_DISCOVERY_PACKET_SEND
Message	Sending PPPoE %s packet on interface %s, MAC %s, session-id %s
Description	Send PPPoE discovery packet
Log Module	pppoe
Log Group	pppoe
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	PPPOE_DHCPV6_LEASE
Message	PPPoE DHCPv6 IA_PD %s for subscriber-id %s, MAC %s, S-Tag %s, C-Tag %s
Description	PPPoE DHCPv6 IA_PD lease
Log Module	pppoe

Log Group	dhcpv6
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	PPPOE_FSM_ACTION_FAILED
Message	%s session for subscriber-id %s, MAC %s, S-Tag %s, C-Tag %s action %s failed
Description	PPP FSM action failed
Log Module	pppoe
Log Group	ppp
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	PPPOE_PADT_RECEIVED
Message	PPPoE PADT received for subscriber-id %s on interface %s, MAC %s, S-Tag %s, C-Tag %s
Description	Received PPPoE discovery packet with matching configuration
Log Module	pppoe
Log Group	config
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Routing Information Base (RIB) Log Messages

Log Level Summary

Info(7)

Log ID	RIB_OPER_ROUTER_ID_ADD
Message	Add router-id %s, instance %s
Description	Router-ID configuration change triggered
Log Module	rib
Log Group	config
Severity	info
Recommended Actions	Check the router-id configurations for this instance

Log ID	RIB_OPER_ROUTER_ID_DEL
Message	Delete router-id %s, instance %s
Description	Router-ID configuration change triggered
Log Module	rib
Log Group	config
Severity	info
Recommended Actions	Check the router-id configurations for this instance

Log ID	RIB_OPER_ROUTER_ID_UPDATE
Message	Change router-id, instance %s, from %s to %s
Description	Router-ID configuration change triggered
Log Module	rib
Log Group	config
Severity	info
Recommended Actions	Check the router-id configurations for this instance

Log ID	RIB_OPER_IPV4_NEIGHBOR_ADD
Message	Add ipv4 neighbor, interface %s, address %s
Description	New ipv4 neighbor is detected
Log Module	rib
Log Group	neighbor-events
Severity	info
Recommended Actions	Check the ipv4 neighbor details

Log ID	RIB_OPER_IPV4_NEIGHBOR_DELETE
Message	Delete ipv4 neighbor, interface %s, address %s
Description	The ipv4 neighbor is deleted
Log Module	rib
Log Group	neighbor-events
Severity	info
Recommended Actions	Check the ifl status

Log ID	RIB_OPER_IPV6_NEIGHBOR_ADD
Message	Add ipv6 neighbor, interface %s, address %s
Description	New ipv6 neighbor is detected
Log Module	rib
Log Group	neighbor-events
Severity	info
Recommended Actions	Check the ipv6 neighbor details

Log ID	RIB_OPER_IPV6_NEIGHBOR_DELETE
Message	Delete ipv6 neighbor, interface %s, address %s
Description	The ipv6 neighbor is deleted
Log Module	rib
Log Group	neighbor-events
Severity	info
Recommended Actions	Check the ipv6 neighbor details

Subscriber Management Log Messages

Log Level Summary

Error(10), Warning(9), Notice(24), Info(15), Debug(43)

Log ID	SUBSMGMT_TRAP_DEL
Message	Failed to delete I/O trap %s
Description	Failed to delete I/O trap entry
Log Module	subsMgmt
Log Group	subscriber
Severity	error
Recommended Actions	Check FIB/RIB logs

Log ID	SUBSMGMT_BDS_TABLE_CREATE_ERROR
Message	Failed to create BDS table %s
Description	Failed to create BDS table
Log Module	subsMgmt

Log Group	bds
Severity	error
Recommended Actions	Contact Rtbrick customer support

Log ID	SUBSMGMT_BDS_TEMPLATE_GET_ERROR
Message	Failed to get BDS object template %s
Description	Failed to get BDS object template
Log Module	subsMgmt
Log Group	bds
Severity	error
Recommended Actions	Contact Rtbrick customer support

Log ID	SUBSMGMT_BDS_TEMPLATE_POPULATE_ERROR
Message	Failed to populate BDS object template %s
Description	Failed to populate BDS object template
Log Module	subsMgmt
Log Group	bds
Severity	error
Recommended Actions	Contact Rtbrick customer support

Log ID	SUBSMGMT_BDS_OBJECT_ADD_ERROR
Message	Failed to add BDS object to table %s
Description	Failed to add BDS object to table
Log Module	subsMgmt

Log Group	bds
Severity	error
Recommended Actions	Contact Rtbrick customer support

Log ID	SUBSMGMT_BDS_OBJECT_DEL_ERROR
Message	Failed to delete BDS object from table %s
Description	Failed to delete BDS object from table
Log Module	subsMgmt
Log Group	bds
Severity	error
Recommended Actions	Contact Rtbrick customer support

Log ID	SUBSMGMT_RADIUS_SERVER_DELETE_FAILED
Message	Failed to delete RADIUS server %s
Description	RADIUS server delete failed
Log Module	subsMgmt
Log Group	radius
Severity	error
Recommended Actions	Contact Rtbrick customer support

Log ID	SUBSMGMT_RADIUS_AUTH_REQ_ERROR
Message	Failed to add RADIUS authentication request for subscriber %s from server %s
Description	RADIUS authentication request failure

Log Module	subsMgmt
Log Group	radius
Severity	error
Recommended Actions	Contact Rtbrick customer support

Log ID	SUBSMGMT_RADIUS_ACCOUNTING_REGUEST_ERROR
Message	Failed to add RADIUS accounting request for subscriber %s from server %s
Description	RADIUS accounting request failure
Log Module	subsMgmt
Log Group	radius
Severity	error
Recommended Actions	Contact Rtbrick customer support

Log ID	SUBSMGMT_L2BSA_GENERIC_ERROR
Message	%s
Description	General subscriber L2BSA related errors
Log Module	subsMgmt
Log Group	subscriber
Severity	error
Recommended Actions	Contact Rtbrick customer support

Log ID	SUBSMGMT_AAA_PROFILE_NOT_FOUND
Message	AAA configuration profile %s not found for subscriber %s

Description	AAA configuration profile subscriber events
Log Module	subsMgmt
Log Group	config
Severity	warning
Recommended Actions	Check the AAA profile configuration

Log ID	SUBSMGMT_RADIUS_PROFILE_MISSING_IN_AAA
Message	RADIUS profile missing in AAA profile %s for subscriber %s
Description	Missing RADIUS profile in AAA profile
Log Module	subsMgmt
Log Group	config
Severity	warning
Recommended Actions	Check the RADIUS profile in AAA profile configuration

Log ID	SUBSMGMT_MISSING_AAA_CONFIG
Message	missing AAA %s for subscriber %s
Description	Subscriber AAA configuration warning
Log Module	subsMgmt
Log Group	config
Severity	warning
Recommended Actions	Contact Rtbrick customer support

Log ID	SUBSMGMT_INTERNAL_AUTHENTICATION
Message	Failed to %s during authentication for subscriber %s

Description	General subscriber authentication warnings
Log Module	subsMgmt
Log Group	subscriber
Severity	warning
Recommended Actions	Contact Rtbrick customer support

Log ID	SUBSMGMT_INTERNAL_ACCOUNTING
Message	Failed to %s during accounting for subscriber %s
Description	General subscriber accounting warnings
Log Module	subsMgmt
Log Group	subscriber
Severity	warning
Recommended Actions	Contact Rtbrick customer support

Log ID	SUBSMGMT_IFL_DELETE
Message	Failed to delete %s for ifl %s
Description	Subscriber logical interface delete events
Log Module	subsMgmt
Log Group	subscriber
Severity	warning
Recommended Actions	Contact Rtbrick customer support

Log ID	SUBSMGMT_BDS_TABLE_GET_ERROR
Message	Failed to get BDS table %s

Description	Failed to get BDS table / not found
Log Module	subsMgmt
Log Group	bds
Severity	warning
Recommended Actions	Contact Rtbrick customer support

Log ID	SUBSMGMT_RADIUS_ACCOUNTING_QUEUE_INDEX
Message	RADIUS accounting queue index exhausted
Description	RADIUS accounting queue index
Log Module	subsMgmt
Log Group	radius
Severity	warning
Recommended Actions	Contact Rtbrick customer support

Log ID	SUBSMGMT_RADIUS_AUTHENTICATION_QUEUE_INDEX
Message	RADIUS authentication queue index exhausted
Description	RADIUS authentication queue index
Log Module	subsMgmt
Log Group	radius
Severity	warning
Recommended Actions	Contact Rtbrick customer support

Log ID	SUBSMGMT_TRAP_ADD
Message	Failed to add I/O trap %s

Description	Failed to add I/O trap entry
Log Module	subsMgmt
Log Group	subscriber
Severity	notice
Recommended Actions	Check FIB/RIB logs

Log ID	SUBSMGMT_QOS_SHAPER
Message	Invalid dynamic shaper definition %s for subscriber %s
Description	Invalid subscriber QoS shaper definition received
Log Module	subsMgmt
Log Group	subscriber
Severity	notice
Recommended Actions	Contact Rtbrick customer support

Log ID	SUBSMGMT_QOS_POLICER
Message	Invalid dynamic policer definition %s for subscriber %s
Description	Invalid subscriber QoS policer definition received
Log Module	subsMgmt
Log Group	subscriber
Severity	notice
Recommended Actions	Contact Rtbrick customer support

Log ID	SUBSMGMT_IPV4_DUPLICATE_ADDRESS_DETECTED

Message	Duplicate IPv4 address %s detected for subscriber %s with subscriber %s
Description	IPv4 Duplicate address detected
Log Module	subsMgmt
Log Group	subscriber
Severity	notice
Recommended Actions	Contact Rtbrick customer support

Log ID	SUBSMGMT_IPV6_DUPLICATE_ADDRESS_DETECTED
Message	Duplicate IPv6 prefix %s detected for subscriber %s with subscriber %s
Description	IPv6 Duplicate address detected
Log Module	subsMgmt
Log Group	subscriber
Severity	notice
Recommended Actions	Contact Rtbrick customer support

Log ID	SUBSMGMT_INSTANCE_NOT_FOUND
Message	Instance %s not found for subscriber %s
Description	Instance not found
Log Module	subsMgmt
Log Group	subscriber
Severity	notice
Recommended Actions	Contact Rtbrick customer support

Log ID	SUBSMGMT_POOL_IPV4_EXHAUSTED
Message	IPv4 pool %s exhausted for subscriber %s
Description	Local IPv4 address pool exhausted
Log Module	subsMgmt
Log Group	pool
Severity	notice
Recommended Actions	Free up IPv4 addresses

Log ID	SUBSMGMT_POOL_IPV6_EXHAUSTED
Message	IPv6 pool %s exhausted for subscriber %s
Description	Local IPv6 address pool exhausted
Log Module	subsMgmt
Log Group	pool
Severity	notice
Recommended Actions	Free up IPv6 addresses

Log ID	SUBSMGMT_QOS_QUEUE
Message	Invalid dynamic queue definition %s for subscriber %s
Description	Invalid subscriber QoS queue definition received
Log Module	subsMgmt
Log Group	subscriber
Severity	notice
Recommended Actions	Contact Rtbrick customer support

Log ID	SUBSMGMT_ACL_VALIDATION
Message	ACL %s attachment to subscriber %s failed, %s
Description	Subscriber ACL validation failed
Log Module	subsMgmt
Log Group	radius
Severity	notice
Recommended Actions	Contact Rtbrick customer support

Log ID	SUBSMGMT_IFL_CREATE
Message	Failed to create %s for subscriber %s
Description	Subscriber logical interface errors
Log Module	subsMgmt
Log Group	subscriber
Severity	notice
Recommended Actions	Contact Rtbrick customer support

Log ID	SUBSMGMT_RADIUS_ACCOUNTING_EVENT
Message	Failed to %s RADIUS accounting request from %s
Description	RADIUS accounting events
Log Module	subsMgmt
Log Group	radius
Severity	notice
Recommended Actions	Contact Rtbrick customer support

Log ID	SUBSMGMT_RADIUS_TUNNEL_ERROR
Message	Tunnel error %s for subscriber %s
Description	RADIUS subscriber tunnel releated errors
Log Module	subsMgmt
Log Group	radius
Severity	notice
Recommended Actions	Contact Rtbrick customer support

Log ID	SUBSMGMT_RADIUS_AUTHENTICATION_ERROR
Message	Authentication error: %s for subscriber %s
Description	RADIUS authentication releated errors
Log Module	subsMgmt
Log Group	radius
Severity	notice
Recommended Actions	Contact Rtbrick customer support

Log ID	SUBSMGMT_RADIUS_ACCOUNTING_ERROR
Message	Accounting error: %s for subscriber %s
Description	RADIUS accounting releated errors
Log Module	subsMgmt
Log Group	radius
Severity	notice
Recommended Actions	Contact Rtbrick customer support

Log ID	SUBSMGMT_RADIUS_ENCODE_ERROR
Message	Encode error %s for subscriber %s
Description	RADIUS encode errors
Log Module	subsMgmt
Log Group	radius
Severity	notice
Recommended Actions	Contact Rtbrick customer support

Log ID	SUBSMGMT_RADIUS_ASCEND_DATA_FILTER
Message	Ascend-Data-Filter error for subscriber %s due to %s
Description	RADIUS filter message decode error
Log Module	subsMgmt
Log Group	radius
Severity	notice
Recommended Actions	Contact Rtbrick customer support

Log ID	SUBSMGMT_RADIUS_ASCEND_DATA_FILTER_NOT_SUPPORTED
Message	Ascend-Data-Filter attribute %s with value %x not supported for subscriber %s
Description	RADIUS filter message decode error
Log Module	subsMgmt
Log Group	radius
Severity	notice
Recommended Actions	Contact Rtbrick customer support

Log ID	SUBSMGMT_RD_INVALID_OBJECT
Message	Redundancy object with invalid subscriber-id/rd-session-id
Description	Redundancy invalid object
Log Module	subsMgmt
Log Group	redundancy
Severity	notice
Recommended Actions	Contact Rtbrick customer support

Log ID	SUBSMGMT_RD_INVALID_EVENT
Message	Invalid event on redundancy session %s, %s
Description	Redundancy invalid event
Log Module	subsMgmt
Log Group	redundancy
Severity	notice
Recommended Actions	Contact Rtbrick customer support

Log ID	SUBSMGMT_RD_ADD_FAILED
Message	Failed to add subscriber %s for redundancy session %s
Description	Redundancy sync failed
Log Module	subsMgmt
Log Group	redundancy
Severity	notice
Recommended Actions	Contact Rtbrick customer support

Log ID	SUBSMGMT_RD_OBJECT_VALIDATION_FAILED
Message	Object validation failed for subscriber %s in redundancy session %s due to %s
Description	Redundancy invalid object
Log Module	subsMgmt
Log Group	redundancy
Severity	notice
Recommended Actions	Contact Rtbrick customer support

Log ID	SUBSMGMT_FRAMED_ROUTE
Message	Framed-Route error for subscriber %s due to %s
Description	RADIUS Framed-Route handling error
Log Module	subsMgmt
Log Group	radius
Severity	notice
Recommended Actions	Contact Rtbrick customer support

Log ID	SUBSMGMT_FRAMED_IPV6_ROUTE
Message	Framed-IPv6-Route error for subscriber %s due to %s
Description	RADIUS Framed-IPv6-Route handling error
Log Module	subsMgmt
Log Group	radius
Severity	notice
Recommended Actions	Contact Rtbrick customer support

Log ID	SUBSMGMT_AAA_PROFILE_INVALID_ORDER
Message	AAA configuration profile %s invalid configuration order for subscriber %s
Description	AAA configuration profile subscriber events
Log Module	subsMgmt
Log Group	config
Severity	info
Recommended Actions	Check the authentication/accounting order in AAA profile configuration

Log ID	SUBSMGMT_AUTHENTICATION_FAILED
Message	Authentication failed for subscriber %s due to %s
Description	General subscriber authentication events
Log Module	subsMgmt
Log Group	subscriber
Severity	info
Recommended Actions	Contact Rtbrick customer support

Log ID	SUBSMGMT_ACCT_SESSION_ID_NOT_FOUND
Message	No subscriber with Acct-Session-ID %s found
Description	CoA request with unknown Acct-Session-ID received
Log Module	subsMgmt
Log Group	subscriber
Severity	info
Recommended Actions	Contact Rtbrick customer support

Log ID	SUBSMGMT_SUBSCRIBER_ADD
Message	Subscriber %s added
Description	New subscriber added
Log Module	subsMgmt
Log Group	subscriber
Severity	info
Recommended Actions	Contact Rtbrick customer support

Log ID	SUBSMGMT_SUBSCRIBER_DEL
Message	Subscriber %s deleted
Description	Subscriber deleted
Log Module	subsMgmt
Log Group	subscriber
Severity	info
Recommended Actions	Contact Rtbrick customer support

Log ID	SUBSMGMT_SUBSCRIBER_NOT_FOUND
Message	Subscriber %s not found
Description	Subscriber not found
Log Module	subsMgmt
Log Group	subscriber
Severity	info
Recommended Actions	Different subscriber related actions

Log ID	SUBSMGMT_FSM_EVENT
Message	Subscriber %s FSM State change, from %s, event %s, to %s
Description	Subscriber FSM state transition
Log Module	subsMgmt
Log Group	subscriberfsm
Severity	info
Recommended Actions	Contact Rtbrick customer support

Log ID	SUBSMGMT_SERVICE_PROFILE_GET_FAILED
Message	Failed to get service profile %s for subscriber %s
Description	Failed to get service configuration profile
Log Module	subsMgmt
Log Group	config
Severity	info
Recommended Actions	Reconfigure the service profile

Log ID	SUBSMGMT_RADIUS_PROFILE_NOT_FOUND
Message	RADIUS profile %s not found
Description	RADIUS profile not found events
Log Module	subsMgmt
Log Group	radius
Severity	info
Recommended Actions	Contact Rtbrick customer support

Log ID	SUBSMGMT_RADIUS_SERVER_NOT_FOUND
Message	RADIUS server %s not found
Description	RADIUS server not found events
Log Module	subsMgmt
Log Group	radius
Severity	info
Recommended Actions	Contact Rtbrick customer support

Log ID	SUBSMGMT_LI_SUBSCRIBER_NOT_FOUND
Message	Subscriber %s not found, Lawful Intercept request is aborted
Description	Subscriber not found
Log Module	subsMgmt
Log Group	lawful-intercept
Severity	info
Recommended Actions	Contact Rtbrick customer support

Log ID	SUBSMGMT_LI_IFL_NOT_FOUND
Message	Subscriber IFL not found for %s , Lawful Intercept request is aborted
Description	Subscriber Lawful Intercept IFL not found
Log Module	subsMgmt
Log Group	lawful-intercept
Severity	info
Recommended Actions	Contact Rtbrick customer support

Log ID	SUBSMGMT_LI_INVALID_ATTRIBUTE
Message	Invalid Lawful Intercept attribute %s for subscriber %s
Description	Subscriber Lawful Intercept Errors
Log Module	subsMgmt
Log Group	lawful-intercept
Severity	info
Recommended Actions	Contact Rtbrick customer support

Log ID	SUBSMGMT_LI_DECRYPTION_FAILED
Message	RADIUS Lawful Intercept request attribute %s decryption failed %s for subscriber %s
Description	Subscriber Lawful Intercept Errors
Log Module	subsMgmt
Log Group	lawful-intercept
Severity	info
Recommended Actions	Contact Rtbrick customer support

Log ID	SUBSMGMT_LI_MISSING_SUBSCRIBER_ID
Message	Mandatory subscriber_id is missing, Lawful Intercept request is aborted
Description	Subscriber Lawful Intercept Errors
Log Module	subsMgmt
Log Group	lawful-intercept
Severity	info

Recommended Actions	Contact Rtbrick customer support

Log ID	SUBSMGMT_FUNCTION_INVOCATION
Message	Subscriber Daemon %s Function invoked
Description	Function calls in SubscriberD
Log Module	subsMgmt
Log Group	general
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	SUBSMGMT_PPPOE_RESULT
Message	Failed to %s from PPPoE for subscriber %s
Description	General subscriber PPPoE related errors
Log Module	subsMgmt
Log Group	subscriber
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	SUBSMGMT_L2TP_RESULT
Message	Failed to extract the L2TP result
Description	General subscriber L2TP related errors
Log Module	subsMgmt
Log Group	subscriber
Severity	debug

Recommended Actions	Contact Rtbrick customer support

Log ID	SUBSMGMT_ACCOUNTING_STOP_PROGRESS
Message	Accounting STOP in progress for subscriber %s
Description	Subscriber waits for final counter update
Log Module	subsMgmt
Log Group	subscriber
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	SUBSMGMT_QOS_CREATE
Message	QoS settings created for subscriber %s with IFL %s
Description	Add subscriber QoS settings
Log Module	subsMgmt
Log Group	subscriber
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	SUBSMGMT_QOS_RESET
Message	QoS settings reset for subscriber %s with IFL %s
Description	Reset subscriber QoS settings
Log Module	subsMgmt
Log Group	subscriber
Severity	debug

Recommended Actions	Contact Rtbrick customer support

Log ID	SUBSMGMT_QOS_UPDATE
Message	QoS settings updated for subscriber %s with IFL %s
Description	Update subscriber QoS settings
Log Module	subsMgmt
Log Group	subscriber
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	SUBSMGMT_BDS_TABLE_CREATED
Message	BDS table %s created
Description	BDS table created
Log Module	subsMgmt
Log Group	bds
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	SUBSMGMT_RADIUS_PROFILE_ACTIVATE
Message	Failed to activate RADIUS profile
Description	RADIUS profile activation event
Log Module	subsMgmt
Log Group	radius
Severity	debug

Recommended Actions	Contact Rtbrick customer support

Log ID	SUBSMGMT_RADIUS_PROFILE_ADDED
Message	RADIUS Profile %s added
Description	RADIUS profile add events
Log Module	subsMgmt
Log Group	radius
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	SUBSMGMT_RADIUS_PROFILE_DELETED
Message	RADIUS profile %s deleted
Description	RADIUS profile delete events
Log Module	subsMgmt
Log Group	radius
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	SUBSMGMT_RADIUS_SERVER_ADDED
Message	RADIUS server %s added
Description	RADIUS server add events
Log Module	subsMgmt
Log Group	radius
Severity	debug

Recommended Actions	Contact Rtbrick customer support

Log ID	SUBSMGMT_RADIUS_SERVER_DELETED
Message	RADIUS server %s deleted
Description	RADIUS server delete events
Log Module	subsMgmt
Log Group	radius
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	SUBSMGMT_RADIUS_SERVER_ACCOUNTING_DISABLED
Message	RADIUS server %s accounting disabled
Description	RADIUS server accounting disabled
Log Module	subsMgmt
Log Group	radius
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	SUBSMGMT_RADIUS_SERVER_AUTHENTICATION_DISABLED
Message	RADIUS server %s authentication disabled
Description	RADIUS server authentication disabled
Log Module	subsMgmt
Log Group	radius
Severity	debug

Recommended Actions	Contact Rtbrick customer support

Log ID	SUBSMGMT_RADIUS_SERVER_UNKNOWN
Message	RADIUS message from unknown server %s
Description	RADIUS requests from unknown IPv4 addresses
Log Module	subsMgmt
Log Group	radius
Severity	debug
Recommended Actions	Check the RADIUS server configuration

Log ID	SUBSMGMT_RADIUS_SERVER_GET_FAILED
Message	RADIUS server %s get failed while decoding RADIUS message %s
Description	RADIUS server get failed
Log Module	subsMgmt
Log Group	radius
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	SUBSMGMT_RADIUS_AUTH_REQ
Message	Added RADIUS authentication request for subscriber %s from server %s
Description	RADIUS authentication request
Log Module	subsMgmt
Log Group	radius

Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	SUBSMGMT_RADIUS_ACCOUNTING_REQUEST
Message	Added RADIUS accounting request for subscriber %s from server %s
Description	RADIUS accounting request
Log Module	subsMgmt
Log Group	radius
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	SUBSMGMT_RADIUS_AUTH_STATE_CHANGE
Message	RADIUS Server %s Authentication State changed from %s to %s
Description	RADIUS server authentication state change
Log Module	subsMgmt
Log Group	radius
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	SUBSMGMT_RADIUS_ACCT_STATE_CHANGE
Message	RADIUS Server %s Accounting State changed from %s to %s
Description	RADIUS server accounting state change
Log Module	subsMgmt

Log Group	radius
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	SUBSMGMT_RADIUS_PROFILE_STATE_CHANGE
Message	RADIUS Profile %s State changed from %s to %s
Description	RADIUS profile accounting state change
Log Module	subsMgmt
Log Group	radius
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	SUBSMGMT_RADIUS_PROFILE_ERROR
Message	RADIUS profile %s %s for subscriber %s
Description	RADIUS profile subscriber events
Log Module	subsMgmt
Log Group	radius
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	SUBSMGMT_RADIUS_DROPPED
Message	RADIUS message from %s dropped due to %s
Description	RADIUS message dropped
Log Module	subsMgmt

Log Group	radius
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	SUBSMGMT_FSM_ERROR
Message	FSM Error for subscriber %s, State %s, Event %s
Description	Invalid event for current state of subscriber FSM
Log Module	subsMgmt
Log Group	subscriberfsm
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	SUBSMGMT_FSM_NOT_FOUND
Message	Subscriber %s not found for FSM event %s
Description	Subscriber not found for received FSM event
Log Module	subsMgmt
Log Group	subscriberfsm
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	SUBSMGMT_FSM_STATIC_IP_ALLOCATION
Message	Static IPv4 address from access-profile allocated for subscriber %s
Description	Subscriber FSM event logging

Log Module	subsMgmt
Log Group	subscriberfsm
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	SUBSMGMT_FSM_GENERAL_ERROR
Message	%s for subscriber %s
Description	Subscriber FSM Error logging
Log Module	subsMgmt
Log Group	subscriberfsm
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	SUBSMGMT_POOL_CONFIG
Message	Failed to process pool configuration
Description	Subscriber Mgmt Pool warning
Log Module	subsMgmt
Log Group	pool
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	SUBSMGMT_POOL_ASSIGN_IPV4
Message	Failed to assign ipv4 address for subscriber %s
Description	Subscriber Mgmt Pool warning

Log Module	subsMgmt
Log Group	pool
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	SUBSMGMT_POOL_RELEASE_IPV4
Message	Failed to release ipv4 address for subscriber %s
Description	Subscriber Mgmt Pool warning
Log Module	subsMgmt
Log Group	pool
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	SUBSMGMT_POOL_ASSIGN_IPV6
Message	Failed to assign ipv6 address for subscriber %s
Description	Subscriber Mgmt Pool warning
Log Module	subsMgmt
Log Group	pool
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	SUBSMGMT_POOL_RELEASE_IPV6
Message	Failed to release ipv6 address for subscriber %s
Description	Subscriber Mgmt Pool warning

Log Module	subsMgmt
Log Group	pool
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	SUBSMGMT_POOL_IPV4_SUCCESS
Message	IPv4 address %s from pool %s assigned to subscriber %s
Description	IPv4 address from local address pool assigned
Log Module	subsMgmt
Log Group	pool
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	SUBSMGMT_POOL_IPV6_SUCCESS
Message	IPv6 prefix %s from pool %s assigned to subscriber %s
Description	IPv6 prefix from local address pool assigned
Log Module	subsMgmt
Log Group	pool
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	SUBSMGMT_TEST_AAA_RESULT
Message	Failed to %s from test aaa request for subscriber %s
Description	General test aaa request subscriber related errors

Log Module	subsMgmt
Log Group	subscriber
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	SUBSMGMT_IPOE_RESULT
Message	Failed to %s from IPoE for subscriber %s
Description	General subscriber IPoE related errors
Log Module	subsMgmt
Log Group	subscriber
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	SUBSMGMT_L2BSA_RESULT
Message	Failed to %s from L2BSA service for subscriber %s
Description	General L2BSA subscriber related errors
Log Module	subsMgmt
Log Group	l2bsa
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	SUBSMGMT_PLATFORM_TYPE
Message	Platform type set to %s
Description	Platform type updated

Log Module	subsMgmt
Log Group	general
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	SUBSMGMT_RD_SUBSCRIBER_EVENT
Message	Event for subscriber %s on redundancy session %s %s
Description	Redundancy subscriber event
Log Module	subsMgmt
Log Group	redundancy
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	SUBSMGMT_LI_REQUEST_FAILURE
Message	Failed to process the Lawful Intercept request for subscriber %s
Description	Subscriber Lawful Intercept Errors
Log Module	subsMgmt
Log Group	lawful-intercept
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	SUBSMGMT_LI_BDS_OBJECT_ADD_ERROR
Message	Failed to add BDS object to table %s

Description	Failed to add BDS object to table
Log Module	subsMgmt
Log Group	lawful-intercept
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	SUBSMGMT_LI_BDS_OBJECT_DEL_ERROR
Message	Failed to delete BDS object from table %s
Description	Failed to delete BDS object from table
Log Module	subsMgmt
Log Group	lawful-intercept
Severity	debug
Recommended Actions	Contact Rtbrick customer support

access_service Log Messages

Log Level Summary

Error(10), Debug(3)

Log ID	HTTPRD_ERROR_SUBSCRIBER_IFL_MISSING
Message	HTTPRD Subscriber IFL Missing: src=%s:%s, dst=%s:%s
Description	Subscriber IFL is missing in TCP context
Log Module	access_service
Log Group	general
Severity	error
Recommended Actions	Contact Rtbrick customer support

Log ID	HTTPRD_ERROR_SERVER_INIT_FAILED
Message	LWIP server initialization failed for instance %s
Description	LWIP server initialization failed
Log Module	access_service
Log Group	general
Severity	error
Recommended Actions	Contact Rtbrick customer support

Log ID	HTTPRD_ERROR_OBJECT_ADD
Message	Failed to add object to %s
Description	HTTPRD failed to add object
Log Module	access_service
Log Group	general
Severity	error
Recommended Actions	Contact Rtbrick customer support

Log ID	HTTPRD_ERROR_OBJECT_DEL
Message	Failed to delete object from %s
Description	HTTPRD failed to delete object
Log Module	access_service
Log Group	general
Severity	error
Recommended Actions	Contact Rtbrick customer support

Log ID	HTTPRD_ERROR_OBJECT_GET
Message	Failed to get object from %s
Description	HTTPRD failed to get object
Log Module	access_service
Log Group	general
Severity	error
Recommended Actions	Contact Rtbrick customer support

Log ID	HTTPRD_ERROR_TABLE_CREATE
Message	Failed to create table %s
Description	HTTPRD failed to create table
Log Module	access_service
Log Group	general
Severity	error
Recommended Actions	Contact Rtbrick customer support

Log ID	HTTPRD_ERROR_OBJECT_TEMPLATE
Message	Failed to get object template %s
Description	HTTPRD failed to get object template
Log Module	access_service
Log Group	general
Severity	error
Recommended Actions	Contact Rtbrick customer support

Log ID	HTTPRD_ERROR_OBJECT_TEMPLATE_POPULATE
Message	Failed to populate object template %s
Description	HTTPRD failed to populate object template
Log Module	access_service
Log Group	general
Severity	error
Recommended Actions	Contact Rtbrick customer support

Log ID	HTTPRD_ERROR_OBJECT_EXTRACT
Message	Failed to extract object template %s
Description	HTTPRD failed to extract object template
Log Module	access_service
Log Group	general
Severity	error
Recommended Actions	Contact Rtbrick customer support

Log ID	HTTPRD_ERROR_TABLE_GET
Message	Failed to get table %s
Description	HTTPRD failed to get table
Log Module	access_service
Log Group	general
Severity	error
Recommended Actions	Contact Rtbrick customer support

Log ID	HTTPRD_TCP_INFO
Message	HTTPRD TCP %s: ifl=%s, src=%s:%s, dst=%s:%s
Description	HTTPRD TCP information
Log Module	access_service
Log Group	general
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	HTTPRD_REDIRECTED
Message	HTTPRD Redirected: ifl=%s, src=%s:%s, dst=%s:%s, url=%s
Description	HTTPRD redirected (302)
Log Module	access_service
Log Group	general
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	HTTPRD_NOT_FOUND
Message	HTTPRD Not Found: ifl=%s, src=%s:%s, dst=%s:%s
Description	HTTPRD redirect information not found (404)
Log Module	access_service
Log Group	general
Severity	debug
Recommended Actions	Contact Rtbrick customer support

L2TP Log Messages

Log Level Summary

Notice(1), Info(14), Debug(15)

Log ID	L2TP_TRAP_ADD
Message	Failed to add I/O trap %s
Description	Failed to add I/O trap entry
Log Module	l2tp
Log Group	config
Severity	notice
Recommended Actions	Check FIB/RIB logs

Log ID	L2TP_SESSION_CREATED
Message	L2TP session created with tunnel %s to %s, session %s for subscriber %s
Description	L2TP session created
Log Module	l2tp
Log Group	subscriber
Severity	info
Recommended Actions	Contact Rtbrick customer support

Log ID	L2TP_SESSION_FSM_STATE_CHANGE
Message	L2TP session %s subscriber %s, FSM state change from %s to %s for input %s with action %s
Description	L2TP session FSM state changed

Log Module	l2tp
Log Group	subscriber
Severity	info
Recommended Actions	Contact Rtbrick customer support

Log ID	L2TP_SESSION_REQUEST_ADD
Message	L2TP session request added for subscriber %s tunnel count %s
Description	L2TP session request added
Log Module	l2tp
Log Group	subscriber
Severity	info
Recommended Actions	Contact Rtbrick customer support

Log ID	L2TP_TUNNEL_REQUEST_ADD
Message	L2TP tunnel request added for tunnel %s to %s
Description	L2TP tunnel request added
Log Module	l2tp
Log Group	tunnel
Severity	info
Recommended Actions	Contact Rtbrick customer support

Log ID	L2TP_TUNNEL_FSM_STATE_CHANGE
Message	L2TP tunnel %s to %s, FSM state change from %s to %s for input %s with action %s

Description	L2TP tunnel FSM state changed
Log Module	l2tp
Log Group	tunnel
Severity	info
Recommended Actions	Contact Rtbrick customer support

Log ID	L2TP_AVP_ENCODE_ERROR
Message	L2TP AVP encode error for tunnel %s, session %s and type %s
Description	L2TP AVP encode error
Log Module	l2tp
Log Group	tunnel
Severity	info
Recommended Actions	Contact Rtbrick customer support

Log ID	L2TP_PACKET_ENCODE_ERROR
Message	L2TP tunnel encode error for tunnel %s to %s
Description	L2TP packet encode error
Log Module	l2tp
Log Group	tunnel
Severity	info
Recommended Actions	Contact Rtbrick customer support

Log ID	L2TP_TUNNEL_DECODE_ERROR

Message	L2TP tunnel decode error %s with packet length %s for tunnel %s to %s
Description	L2TP tunnel decode error
Log Module	l2tp
Log Group	tunnel
Severity	info
Recommended Actions	Contact Rtbrick customer support

Log ID	L2TP_TUNNEL_AVP_MH_MISMATCH
Message	L2TP tunnel AVP with vendor-id %s and attribute-type %s m/h bit mismatch for tunnel %s to %s
Description	L2TP tunnel decode error
Log Module	l2tp
Log Group	tunnel
Severity	info
Recommended Actions	Contact Rtbrick customer support

Log ID	L2TP_PACKET_DROP
Message	L2TP Packet dropped due to %s packet type %s received ns %s tunnel nr %s on tunnel %s to %s and session %s
Description	L2TP tunnel packet dropped because duplicate or out of order
Log Module	l2tp
Log Group	tunnel
Severity	info
Recommended Actions	Contact Rtbrick customer support

Log ID	L2TP_MBIT_UNKNOWN
Message	L2TP tunnel unknown mandatory AVP vendor-id %s and attribute-type %s received for tunnel %s to %s
Description	L2TP tunnel packet received with unknown mandatory AVP
Log Module	l2tp
Log Group	tunnel
Severity	info
Recommended Actions	Contact Rtbrick customer support

Log ID	L2TP_AVP_DECODE_ERROR
Message	L2TP AVP decode error %s for vendor %s attribute-type %s for tunnel %s to %s
Description	L2TP AVP decode error
Log Module	l2tp
Log Group	tunnel
Severity	info
Recommended Actions	Contact Rtbrick customer support

Log ID	L2TP_TUNNEL_AUTH_ERROR
Message	L2TP tunnel %s to %s authentication error %s
Description	L2TP tunnel authentication error
Log Module	l2tp
Log Group	tunnel
Severity	info

Recommended Actions	Contact Rtbrick customer support

Log ID	L2TP_TUNNEL_DELETED
Message	L2TP tunnel %s to %s deleted
Description	L2TP tunnel deleted
Log Module	l2tp
Log Group	tunnel
Severity	info
Recommended Actions	Contact Rtbrick customer support

Log ID	L2TP_PACKET_RECEIVE_ERROR
Message	Failed to receive L2TP packet from SHM
Description	L2TP packet receive error
Log Module	l2tp
Log Group	general
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	L2TP_INVALID_PACKET_RECEIVED
Message	L2TP invalid packet %s received from %s
Description	L2TP invalid packet received
Log Module	l2tp
Log Group	general
Severity	debug

Recommended Actions	Contact Rtbrick customer support

Log ID	L2TP_SUBSCRIBER_RESULT_ERROR
Message	L2TP subcriberd result not found for tunnel %s with session %s for subscriber %s
Description	Generic L2TP subscriber result error
Log Module	l2tp
Log Group	subscriber
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	L2TP_RADIUS_TUNNEL
Message	L2TP error in RADIUS tunnel definition for subscriber %s
Description	L2TP error in RADIUS tunnel definition
Log Module	l2tp
Log Group	subscriber
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	L2TP_NO_TUNNEL_POOL
Message	L2TP no tunnel pool for subscriber %s
Description	L2TP no tunnel pool for subscriber
Log Module	l2tp
Log Group	subscriber

Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	L2TP_POOL_NOT_FOUND
Message	L2TP pool %s not found for subscriber %s
Description	L2TP pool error for subscriber
Log Module	l2tp
Log Group	subscriber
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	L2TP_TUNNEL_CREDENTIAL
Message	L2TP tunnel with missing %s for subscriber %s
Description	L2TP tunnel with missing credentials
Log Module	l2tp
Log Group	subscriber
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	L2TP_TUNNEL_SEND
Message	L2TP tunnel sent for tunnel %s type %s
Description	L2TP tunnel packet send
Log Module	l2tp
Log Group	tunnel

Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	L2TP_TX_QUEUE_ADDED
Message	L2TP tunnel %s packet %s added to TX queue
Description	L2TP packet added to tunnel TX queue
Log Module	l2tp
Log Group	tunnel
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	L2TP_TX_QUEUE_ADD_FAILED
Message	L2TP tunnel %s failed to add packet to TX queue
Description	Failed to add L2TP packet to tunnel TX queue
Log Module	l2tp
Log Group	tunnel
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	L2TP_TUNNEL_PACKET_SEND
Message	L2TP tunnel %s trying to send outstanding type %s ns %s nr %s pnr %s cw %s
Description	L2TP tunnel packet send
Log Module	l2tp

Log Group	tunnel
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	L2TP_TUNNEL_PACKET_RECEIVED
Message	L2TP %s received for tunnel %s
Description	L2TP tunnel packet received
Log Module	l2tp
Log Group	tunnel
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	L2TP_TUNNEL_MAX_RETRANSMISSION
Message	L2TP tunnel %s exceeds transmission
Description	L2TP tunnel exceeds transmission
Log Module	l2tp
Log Group	tunnel
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	L2TP_OUT_OF_ORDER_PACKET
Message	L2TP out of order packet accepted for tunnel %s
Description	L2TP out of order packet
Log Module	l2tp

Log Group	tunnel
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	L2TP_SESSION_PACKET_RECEIVED
Message	L2TP %s received for tunnel %s session %s
Description	L2TP session packet received
Log Module	l2tp
Log Group	session
Severity	debug
Recommended Actions	Contact Rtbrick customer support

IGMP Log Messages

Log Level Summary

Info(7), Debug(12)

Log ID	IGMP_INSTANCE_UP
Message	IGMP instance is UP - {instance:%s}
Description	IGMP instance configuration add triggered
Log Module	igmp
Log Group	config
Severity	INFO
Recommended Actions	Check the IGMP status for this instance

Log ID	IGMP_INSTANCE_DOWN
Message	IGMP instance is DOWN - {instance:%s}
Description	IGMP instance configuration delete triggered
Log Module	igmp
Log Group	config
Severity	INFO
Recommended Actions	Check the IGMP status for this instance

Log ID	IGMP_INTERFACE_UP
Message	IGMP logical interface is UP - {instance:%s logical-interface:%s}
Description	IGMP logical interface configuration add or dynamic subscriber ifl creation triggered
Log Module	igmp
Log Group	config
Severity	INFO
Recommended Actions	Check the IGMP status for this logical interface

Log ID	IGMP_INTERFACE_DOWN
Message	IGMP logical interface is DOWN - {instance:%s interface:%s}
Description	IGMP logical interface configuration delete or dynamic subscriber ifl deletion triggered
Log Module	igmp
Log Group	config
Severity	INFO
Recommended Actions	Check the IGMP status for this logical interface

Log ID	IGMP_INTERFACE_ROLE_QUERIER
Message	IGMP interface role is querier - {instance:%s interface:%s}
Description	IGMP interface role is querier
Log Module	igmp
Log Group	igmp-interface-events
Severity	INFO
Recommended Actions	Check the IGMP role on this logical interface

Log ID	IGMP_INTERFACE_ROLE_NON_QUERIER
Message	IGMP interface role is non-querier - {instance:%s interface:%s}
Description	IGMP interface role is non-querier
Log Module	igmp
Log Group	igmp-interface-events
Severity	INFO
Recommended Actions	Check the IGMP role on this logical interface

Log ID	IGMP_INTERFACE_MAX_LIMIT_REACHED
Message	IGMP membership report dropped due to max-limit reached on the interface - {instance:%s interface:%s} {source:%s group:%s}
Description	IGMP membership report dropped due to max-limit reached on the interface
Log Module	igmp
Log Group	igmp-packet-events
Severity	INFO

Recommended Actions	Check if maximum members limit on this interface

Log ID	IGMP_INTERFACE_FILTER_MEMBERSHIP_PERMITTED
Message	IGMP membership report is permitted - {instance:%s interface:%s} {source:%s group:%s}
Description	IGMP membership report is permitted
Log Module	igmp
Log Group	igmp-packet-events
Severity	DEBUG
Recommended Actions	Check if membership should be permitted

Log ID	IGMP_INTERFACE_FILTER_MEMBERSHIP_DENIED
Message	IGMP membership report is denied by interface filter - {instance:%s interface:%s} {source:%s group:%s}
Description	IGMP membership report is denied
Log Module	igmp
Log Group	igmp-packet-events
Severity	DEBUG
Recommended Actions	Check if membership report should be denied

Log ID	IGMP_INTERFACE_GENERAL_QUERY_SENT
Message	IGMP general query sent on the interface - {instance:%s interface:%s}
Description	IGMP general query sent on the interface
Log Module	igmp

Log Group	igmp-packet-events
Severity	DEBUG
Recommended Actions	Check if general query out statistics on the interface

Log ID	IGMP_INTERFACE_GENERAL_QUERY_RECEIVED
Message	IGMP general query received on the interface - {instance:%s interface:%s}
Description	IGMP general query received on the interface
Log Module	igmp
Log Group	igmp-packet-events
Severity	DEBUG
Recommended Actions	Check if general query in statistics on the interface

Log ID	IGMP_INTERFACE_GROUP_QUERY_SENT
Message	IGMP group query sent on the interface - {instance:%s interface:%s} {group:%s}
Description	IGMP group query sent on the interface
Log Module	igmp
Log Group	igmp-packet-events
Severity	DEBUG
Recommended Actions	Check if group query out statistics on the interface

Log ID	IGMP_INTERFACE_GROUP_QUERY_RECEIVED
Message	IGMP group query received on the interface - {instance:%s interface:%s} {group:%s}

Description	IGMP group query received on the interface
Log Module	igmp
Log Group	igmp-packet-events
Severity	DEBUG
Recommended Actions	Check if group query in statistics on the interface

Log ID	IGMP_INTERFACE_MEMBERSHIP_JOIN_RECEIVED
Message	IGMP membership join received on the interface - {instance:%s interface:%s} {source:%s group:%s}
Description	IGMP membership join received on the interface
Log Module	igmp
Log Group	igmp-packet-events
Severity	DEBUG
Recommended Actions	Check if IGMP membership join received on the interface

Log ID	IGMP_INTERFACE_MEMBERSHIP_LEAVE_RECEIVED
Message	IGMP membership leave received on the interface - {instance:%s interface:%s} {source:%s group:%s}
Description	IGMP membership leave received on the interface
Log Module	igmp
Log Group	igmp-packet-events
Severity	DEBUG
Recommended Actions	Check if IGMP membership leave received on the interface

Log ID	IGMP_MEMBERSHIP_ADD

Message	IGMP membership is added - {instance:%s interface:%s} {source:%s group:%s type:%s}
Description	IGMP membership is added
Log Module	igmp
Log Group	igmp-membership-events
Severity	DEBUG
Recommended Actions	Check if membership should be permitted

Log ID	IGMP_MEMBERSHIP_DELETE
Message	IGMP membership is deleted - {instance:%s interface:%s} {source:%s group:%s type:%s}
Description	IGMP membership is deleted
Log Module	igmp
Log Group	igmp-membership-events
Severity	DEBUG
Recommended Actions	Check if IGMP leave received or static join removed

Log ID	IGMP_FIBLOCAL_ADD
Message	IGMP mroute added to fiblocal table - {instance:%s interface:%s} {source:%s group:%s type:%s}
Description	IGMP mroute added to fiblocal table
Log Module	igmp
Log Group	igmp-route-events
Severity	DEBUG
Recommended Actions	Check if IGMP route added to fiblocal table

Log ID	IGMP_FIBLOCAL_DELETE
Message	IGMP mroute deleted to fiblocal table - {instance:%s interface:%s} {source:%s group:%s type:%s}
Description	IGMP mroute deleted from fiblocal table
Log Module	igmp
Log Group	igmp-route-events
Severity	DEBUG
Recommended Actions	Check if IGMP mroute deleted from fiblocal table

oam Log Messages

Log Level Summary

Alert(1), Debug(17)

Log ID	OAM_BFD_SESSION_STATUS
Message	OAM BFD session is %s for peer %s, local address %s
Description	BFD session status
Log Module	oam
Log Group	bfd
Severity	Alert
Recommended Actions	Contact Rtbrick customer support

Log ID	OAM_TABLE_CREATED
Message	BDS table %s created
Description	BDS table created
Log Module	oam
Log Group	general

Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	OAM_TABLE_CREATE_ERROR
Message	Failed to create BDS table %s
Description	Failed to create BDS table
Log Module	oam
Log Group	general
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	OAM_TABLE_DELETED
Message	BDS table %s deleted
Description	BDS table deleted
Log Module	oam
Log Group	general
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	OAM_TABLE_ATTR_NOT_FOUND
Message	Failed to get table attribute for table %s
Description	BDS table attribute not found
Log Module	oam
Log Group	general

Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	OAM_TABLE_NOT_FOUND
Message	Failed to get table %s
Description	BDS table not found
Log Module	oam
Log Group	general
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	OAM_TABLE_SUBSCRIBED
Message	BDS table %s subscribed
Description	BDS table subscribed
Log Module	oam
Log Group	general
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	OAM_TABLE_UNSUBSCRIBED
Message	BDS table %s unsubscribed
Description	BDS table unsubscribed
Log Module	oam
Log Group	general

Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	OAM_TRAP_ADDED
Message	Trap %s added
Description	OAM trap added
Log Module	oam
Log Group	config
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	OAM_TRAP_DELETED
Message	Trap %s deleted
Description	OAM trap deleted
Log Module	oam
Log Group	config
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	OAM_OBJ_GET_FAILED
Message	Failed to get object for table %s
Description	BDS object get failed
Log Module	oam
Log Group	general

Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	OAM_OBJ_ADD_FAILED
Message	Failed to add object for table %s
Description	BDS object add failed
Log Module	oam
Log Group	general
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	OAM_OBJ_DEL_FAILED
Message	Failed to delete object for table %s
Description	BDS object delete failed
Log Module	oam
Log Group	general
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	OAM_CFM_SESSION_NOT_FOUND
Message	CFM session not found for ifl %s
Description	BDS object delete failed
Log Module	oam
Log Group	cfm

Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	MPLS_OAM_TABLE_CREATED
Message	BDS table %s created
Description	BDS table created
Log Module	oam
Log Group	general
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	MPLS_OAM_TABLE_CREATE_ERROR
Message	Failed to create BDS table %s
Description	Failed to create BDS table
Log Module	oam
Log Group	general
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	MPLS_OAM_TABLE_DELETED
Message	BDS table %s deleted
Description	BDS table deleted
Log Module	oam
Log Group	general

Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	MPLS_OAM_TABLE_DELETE_ERROR
Message	Failed to delete BDS table %s
Description	Failed to delete BDS table
Log Module	oam
Log Group	general
Severity	debug
Recommended Actions	Contact Rtbrick customer support

PIM Log Messages

Log Level Summary

Error(3), Info(11), Debug(15)

Log ID	PIM_INSTANCE_DOWN
Message	PIM Instance (%s) is Down
Description	PIM Instance Events
Log Module	pim
Log Group	instance
Severity	ERROR
Recommended Actions	Contact Rtbrick customer support

Log ID	PIM_NEIGHBOR_DOWN

Message	PIM Neighbor (%s) is Down on Interface (%s), Instance (%s)
Description	PIM Neighbor Events
Log Module	pim
Log Group	neighbor
Severity	ERROR
Recommended Actions	Contact Rtbrick customer support

Log ID	PIM_ERROR_LOG
Message	PIM Error Reason (%s)
Description	PIM Error Reason
Log Module	pim
Log Group	error-log
Severity	ERROR
Recommended Actions	Contact Rtbrick customer support

Log ID	PIM_INSTANCE_UP
Message	PIM Instance (%s) is Up
Description	PIM Instance Events
Log Module	pim
Log Group	instance
Severity	INFO
Recommended Actions	Contact Rtbrick customer support

Log ID	PIM_INTERFACE_UP

Message	PIM Interface (%s) is Up on Instance (%s)
Description	PIM Interface Events
Log Module	pim
Log Group	interface
Severity	INFO
Recommended Actions	Contact Rtbrick customer support

Log ID	PIM_INTERFACE_DOWN
Message	PIM Interface (%s) is Down on Instance (%s)
Description	PIM Interface Events
Log Module	pim
Log Group	interface
Severity	INFO
Recommended Actions	Contact Rtbrick customer support

Log ID	PIM_NEIGHBOR_UP
Message	PIM Neighbor (%s) is Up on Interface (%s), Instance (%s)
Description	PIM Neighbor Events
Log Module	pim
Log Group	neighbor
Severity	INFO
Recommended Actions	Contact Rtbrick customer support

Log ID	PIM_DR_ELECTION_WON

Message	DR election won new DR (%s) elected on Interface (%s), Instance (%s)
Description	PIM DR election Events
Log Module	pim
Log Group	dr-election
Severity	INFO
Recommended Actions	Contact Rtbrick customer support

Log ID	PIM_DR_ELECTION_LOST
Message	DR election lost new DR (%s) elected on Interface (%s), Instance (%s)
Description	PIM DR election Events
Log Module	pim
Log Group	dr-election
Severity	INFO
Recommended Actions	Contact Rtbrick customer support

Log ID	PIM_PACKET_SEND
Message	Sending (%s) Packet with Length %s on Instance (%s) Interface (%s) from (%s) to (%s)
Description	PIM Packet Send Events
Log Module	pim
Log Group	packet
Severity	INFO
Recommended Actions	Contact Rtbrick customer support

Log ID	PIM_PACKET_RECEIVE
Message	Receiving (%s) Packet with Length %s on Instance (%s) Interface (%s) from (%s) to (%s)
Description	PIM Packet Receive Events
Log Module	pim
Log Group	packet
Severity	INFO
Recommended Actions	Contact Rtbrick customer support

Log ID	PIM_INFO_LOG
Message	PIM Info (%s)
Description	PIM Info
Log Module	pim
Log Group	info-log
Severity	INFO
Recommended Actions	Contact Rtbrick customer support

Log ID	PIM_JOIN_SENT
Message	PIM join sent for multicast route - {instance:%s interface:%s} {source:%s group:%s}
Description	PIM join sent for multicast route
Log Module	pim
Log Group	join-prune
Severity	INFO
Recommended Actions	Check if PIM join received at upstream router

Log ID	PIM_PRUNE_SENT
Message	PIM prune sent for multicast route - {instance:%s interface:%s} {source:%s group:%s}
Description	PIM prune sent for multicast route
Log Module	pim
Log Group	join-prune
Severity	INFO
Recommended Actions	Check if PIM prune received at upstream router

Log ID	PIM_OBJECT_TRACE
Message	Dumpping Object (%s)%s:%s %s
Description	PIM Object Operation Dump
Log Module	pim
Log Group	object-trace
Severity	DEBUG
Recommended Actions	Contact Rtbrick customer support

Log ID	PIM_RIBIN_ROUTE_ADD
Message	PIM mroute added to ribin table - {instance:%s interface:%s} {source:%s group:%s source:%s sub-source:%s}
Description	PIM mroute added to ribin table
Log Module	pim
Log Group	multicast-route
Severity	DEBUG

Recommended Actions	Check if PIM route added to ribin table

Log ID	PIM_RIBIN_ROUTE_CHANGE
Message	PIM mroute changed to ribin table - {instance:%s interface:%s} {source:%s group:%s source:%s sub-source:%s}
Description	PIM mroute changed to ribin table
Log Module	pim
Log Group	multicast-route
Severity	DEBUG
Recommended Actions	Check if PIM route changed to ribin table

Log ID	PIM_RIBIN_ROUTE_DELETE
Message	PIM mroute deleted to ribin table - {instance:%s interface:%s} {source:%s group:%s source:%s sub-source:%s}
Description	PIM mroute deleted to ribin table
Log Module	pim
Log Group	multicast-route
Severity	DEBUG
Recommended Actions	Check if PIM route deleted to ribin table

Log ID	PIM_ADDRESS_RESOLUTION_REQUEST_ADD
Message	PIM RPF address resolution requested - {instance:%s address:%s} {afi:%s safi:%s}
Description	PIM RPF address resolution requested
Log Module	pim

Log Group	rpf
Severity	DEBUG
Recommended Actions	Check requested address has resolvable route

Log ID	PIM_ADDRESS_RESOLUTION_REQUEST_DELETE
Message	PIM RPF address resolution request deleted - {instance:%s address:%s} {afi:%s safi:%s}
Description	PIM RPF address resolution request deleted
Log Module	pim
Log Group	rpf
Severity	DEBUG
Recommended Actions	Check if no multicast route with requested address

Log ID	PIM_ADDRESS_RESOLUTION_RESPONSE_ADD
Message	PIM RPF address resolution received - {instance:%s address:%s} {afi:%s safi:%s} {exit-interface:%s peer-ip:%s}
Description	PIM RPF address resolution received
Log Module	pim
Log Group	rpf
Severity	DEBUG
Recommended Actions	Check if resolved address in reachable

Log ID	PIM_ADDRESS_RESOLUTION_RESPONSE_CHANGE
Message	PIM RPF resolved address changed - {instance:%s address:%s} {afi:%s safi:%s} {exit-interface:%s peer-ip:%s}

Description	PIM RPF resolved address changed
Log Module	pim
Log Group	rpf
Severity	DEBUG
Recommended Actions	Check if resolved address in reachable

Log ID	PIM_ADDRESS_RESOLUTION_RESPONSE_DELETE
Message	PIM RPF resolved address deleted - {instance:%s address:%s} {afi:%s safi:%s} {exit-interface:%s peer-ip:%s}
Description	PIM RPF resolved address deleted
Log Module	pim
Log Group	rpf
Severity	DEBUG
Recommended Actions	Check if resolved address in reachable

Log ID	PIM_RIBLOCAL_ROUTE_ADD
Message	PIM multicast route added to riblocal table - {instance:%s interface:%s} {source:%s group:%s rpf-interface:%s}
Description	PIM multicast route added to riblocal table
Log Module	pim
Log Group	multicast-route
Severity	DEBUG
Recommended Actions	Check if installed multicast route has subscribers

Log ID	PIM_RIBLOCAL_ROUTE_DELETE

Message	PIM multicast route deleted to riblocal table - {instance:%s interface:%s} {source:%s group:%s rpf-interface:%s}
Description	PIM multicast route deleted to riblocal table
Log Module	pim
Log Group	multicast-route
Severity	DEBUG
Recommended Actions	Check if multicast route has no subscribers

Log ID	PIM_RIBLOCAL_ROUTE_CHANGE
Message	PIM multicast route changed to riblocal table - {instance:%s interface:%s} {source:%s group:%s rpf-interface:%s}
Description	PIM multicast route changed to riblocal table
Log Module	pim
Log Group	multicast-route
Severity	DEBUG
Recommended Actions	Check if multicast route has no subscribers

Log ID	PIM_FIBLOCAL_ROUTE_ADD
Message	PIM multicast route added to fiblocal table - {instance:%s} {source:%s group:%s rpf-interface:%s}
Description	PIM multicast route added to fiblocal table
Log Module	pim
Log Group	multicast-route
Severity	DEBUG
Recommended Actions	Check if installed multicast route has subscribers

Log ID	PIM_FIBLOCAL_ROUTE_DELETE
Message	PIM multicast route deleted to fiblocal table - {instance:%s} {source:%s group:%s rpf-interface:%s}
Description	PIM multicast route deleted to fiblocal table
Log Module	pim
Log Group	multicast-route
Severity	DEBUG
Recommended Actions	Check if multicast route has no subscribers

Log ID	PIM_FIBLOCAL_ROUTE_CHANGE
Message	PIM multicast route changed to fiblocal table - {instance:%s} {source:%s group:%s rpf-interface:%s}
Description	PIM multicast route changed to fiblocal table
Log Module	pim
Log Group	multicast-route
Severity	DEBUG
Recommended Actions	Check if multicast route has no subscribers

pool Log Messages

Log Level Summary

Error(8)

Log ID	POOL_CLIENT_INIT
Message	Pool client init failed for module: %s, resource: %s
Description	Pool client init failure
Log Module	pool

Log Group	internal
Severity	ERROR
Recommended Actions	Contact Rtbrick customer support

Log ID	POOL_CLIENT_NOT_FOUND
Message	Pool client not found for module: %s, resource: %s
Description	The pool client not found
Log Module	pool
Log Group	internal
Severity	ERROR
Recommended Actions	Contact Rtbrick customer support

Log ID	POOL_CLIENT_INVALID_MODULE
Message	Invalid Module name %s passed to pool client init
Description	The pool client not found
Log Module	pool
Log Group	internal
Severity	ERROR
Recommended Actions	Contact Rtbrick customer support

Log ID	POOL_CLIENT_OUT_OF_MEMORY
Message	Unable to allocate memory
Description	System out of memory
Log Module	pool

Log Group	internal
Severity	ERROR
Recommended Actions	Contact Rtbrick customer support

Log ID	POOL_CLIENT_DICT_ADD_FAILED
Message	Failed to add pool client to client dict
Description	Dictionary addition failed
Log Module	pool
Log Group	internal
Severity	ERROR
Recommended Actions	Contact Rtbrick customer support

Log ID	POOL_CLIENT_RANGE_REQ_FAILED
Message	Failed to send range request to poold error: %s
Description	Failed to send range request to poold
Log Module	pool
Log Group	internal
Severity	ERROR
Recommended Actions	Contact Rtbrick customer support

Log ID	POOL_TABLE_CREATE_FAILED
Message	Failed to create table, error: %s
Description	Failed to send range request to poold
Log Module	pool

Log Group	internal
Severity	ERROR
Recommended Actions	Contact Rtbrick customer support

Log ID	POOL_CLIENT_DICT_NOT_INITED
Message	Pool client dictionary is not created yet
Description	The pool client not found
Log Module	pool
Log Group	internal
Severity	ERROR
Recommended Actions	Contact Rtbrick customer support

Resource Monitoring Log Messages

Log Level Summary

Info(24), Debug(12)

Log ID	RESMON_RESOURCE_OPTICS_MDL_TEMP_HIGH_ALARM
Message	Module temperature is above threshold high alarm for module %s
Description	Resmond resource event logging
Log Module	resmon
Log Group	resmon-resource-events
Severity	INFO
Recommended Actions	Check resource properties

Log ID	RESMON_RESOURCE_OPTICS_MDL_TEMP_HIGH_WARN
Message	Module temperature is above threshold high warning for module %s
Description	Resmond resource event logging
Log Module	resmon
Log Group	resmon-resource-events
Severity	INFO
Recommended Actions	Check resource properties

Log ID	RESMON_RESOURCE_OPTICS_MDL_TEMP_LOW_ALARM
Message	Module temperature is below threshold low alarm for module %s
Description	Resmond resource event logging
Log Module	resmon
Log Group	resmon-resource-events
Severity	INFO
Recommended Actions	Check resource properties

Log ID	RESMON_RESOURCE_OPTICS_MDL_TEMP_LOW_WARN
Message	Module temperature is below threshold low warning for module %s
Description	Resmond resource event logging
Log Module	resmon
Log Group	resmon-resource-events
Severity	INFO
Recommended Actions	Check resource properties

Log ID	RESMON_RESOURCE_OPTICS_MDL_VOLTAGE_HIGH_ALARM
Message	Module voltage is above threshold high alarm for module %s
Description	Resmond resource event logging
Log Module	resmon
Log Group	resmon-resource-events
Severity	INFO
Recommended Actions	Check resource properties

Log ID	RESMON_RESOURCE_OPTICS_MDL_VOLTAGE_HIGH_WARN
Message	Module voltage is above threshold high warning for module %s
Description	Resmond resource event logging
Log Module	resmon
Log Group	resmon-resource-events
Severity	INFO
Recommended Actions	Check resource properties

Log ID	RESMON_RESOURCE_OPTICS_MDL_VOLTAGE_LOW_ALARM
Message	Module voltage is below threshold low alarm for module %s
Description	Resmond resource event logging
Log Module	resmon
Log Group	resmon-resource-events
Severity	INFO
Recommended Actions	Check resource properties

Log ID	RESMON_RESOURCE_OPTICS_MDL_VOLTAGE_LOW_WARN
Message	Module voltage is below threshold high alarm for module %s
Description	Resmond resource event logging
Log Module	resmon
Log Group	resmon-resource-events
Severity	INFO
Recommended Actions	Check resource properties

Log ID	RESMON_RESOURCE_OPTICS_MDL_LANE_POWER_HIGH_ALARM
Message	Module %s power is above threshold high alarm for module %s on lane %s
Description	Resmond resource event logging
Log Module	resmon
Log Group	resmon-resource-events
Severity	INFO
Recommended Actions	Check resource properties

Log ID	RESMON_RESOURCE_OPTICS_MDL_LANE_POWER_HIGH_WARN
Message	Module %s power is above threshold high warning for module %s on lane %s
Description	Resmond resource event logging
Log Module	resmon
Log Group	resmon-resource-events
Severity	INFO

Recommended Actions	Check resource properties

Log ID	RESMON_RESOURCE_OPTICS_MDL_LANE_POWER_LOW_ALARM
Message	Module %s power is below threshold low alarm for module %s on lane %s
Description	Resmond resource event logging
Log Module	resmon
Log Group	resmon-resource-events
Severity	INFO
Recommended Actions	Check resource properties

Log ID	RESMON_RESOURCE_OPTICS_MDL_LANE_POWER_LOW_WARN
Message	Module %s power is below threshold high alarm for module %s on lane %s
Description	Resmond resource event logging
Log Module	resmon
Log Group	resmon-resource-events
Severity	INFO
Recommended Actions	Check resource properties

Log ID	RESMON_RESOURCE_OPTICS_MDL_LANE_BIAS_HIGH_ALARM
Message	Module %s bias is above threshold high alarm for module %s on lane %s

Description	Resmond resource event logging
Log Module	resmon
Log Group	resmon-resource-events
Severity	INFO
Recommended Actions	Check resource properties

Log ID	RESMON_RESOURCE_OPTICS_MDL_LANE_BIAS_HIGH_WARN
Message	Module %s bias is above threshold high warning for module %s on lane %s
Description	Resmond resource event logging
Log Module	resmon
Log Group	resmon-resource-events
Severity	INFO
Recommended Actions	Check resource properties

Log ID	RESMON_RESOURCE_OPTICS_MDL_LANE_BIAS_LOW_ALARM
Message	Module %s bias is below threshold low alarm for module %s on lane %s
Description	Resmond resource event logging
Log Module	resmon
Log Group	resmon-resource-events
Severity	INFO
Recommended Actions	Check resource properties

Log ID	RESMON_RESOURCE_OPTICS_MDL_LANE_BIAS_LOW_WARN

Message	Module %s bias is below threshold high alarm for module %s on lane %s
Description	Resmond resource event logging
Log Module	resmon
Log Group	resmon-resource-events
Severity	INFO
Recommended Actions	Check resource properties

Log ID	RESMON_RESOURCE_OPTICS_MDL_LANE_LOS
Message	Module %s loss of signal alarm for module %s on lane %s
Description	Resmond resource event logging
Log Module	resmon
Log Group	resmon-resource-events
Severity	INFO
Recommended Actions	Check resource properties

Log ID	RESMON_RESOURCE_OPTICS_MDL_LANE_LOL
Message	Module %s loss of light alarm for module %s on lane %s
Description	Resmond resource event logging
Log Module	resmon
Log Group	resmon-resource-events
Severity	INFO
Recommended Actions	Check resource properties

Log ID	RESMON_NTP_PEER_DOWN
Message	NTP Peer down ID %s with IP %s resolving to %s
Description	Resmond ntp peer event logging
Log Module	resmon
Log Group	resmon-ntp-peer-events
Severity	INFO
Recommended Actions	Check resource properties

Log ID	RESMON_NTP_PEER_UP
Message	NTP Peer up ID %s with IP %s resolving to %s
Description	Resmond ntp peer event logging
Log Module	resmon
Log Group	resmon-ntp-peer-events
Severity	INFO
Recommended Actions	Check resource properties

Log ID	RESMON_NTP_PEER_BEST
Message	NTP Peer selected as best peer for sync ID %s with IP %s resolving to %s
Description	Resmond ntp peer event logging
Log Module	resmon
Log Group	resmon-ntp-peer-events
Severity	INFO
Recommended Actions	Check resource properties

Log ID	RESMON_NTP_PEER_NOT_BEST
Message	NTP Peer deselected as best peer for sync ID %s with IP %s resolving to %s
Description	Resmond ntp peer event logging
Log Module	resmon
Log Group	resmon-ntp-peer-events
Severity	INFO
Recommended Actions	Check resource properties

Log ID	RESMON_NTP_PEER_UNREACHABLE
Message	NTP Peer unreachable ID %s with IP %s resolving to %s
Description	Resmond ntp peer event logging
Log Module	resmon
Log Group	resmon-ntp-peer-events
Severity	INFO
Recommended Actions	Check resource properties

Log ID	RESMON_NTP_PEER_REACHABLE
Message	NTP Peer reachable ID %s with IP %s resolving to %s
Description	Resmond ntp peer event logging
Log Module	resmon
Log Group	resmon-ntp-peer-events
Severity	INFO
Recommended Actions	Check resource properties

Log ID	RESMON_GENERIC
Message	RESMOND generic event - %s
Description	Resmond generic event logging
Log Module	resmon
Log Group	resmon-internal-events
Severity	DEBUG
Recommended Actions	Check resmond resource and intenal tables

Log ID	RESMON_GENERIC_RC
Message	RESMOND generic event - %s status[%s - %s]
Description	Resmond generic event logging
Log Module	resmon
Log Group	resmon-internal-events
Severity	DEBUG
Recommended Actions	Check resmond resource and intenal tables

Log ID	RESMON_BDS_OBJ_ALLOC_ERR
Message	Unable to allocate object template for %s
Description	Resmond bds event logging
Log Module	resmon
Log Group	resmon-bds-events
Severity	DEBUG
Recommended Actions	Check resmond resource and intenal tables

Log ID	RESMON_BDS_ATTR_NOT_FOUND
Message	Expecting attribute "%s", but not found
Description	Resmond bds event logging
Log Module	resmon
Log Group	resmon-bds-events
Severity	DEBUG
Recommended Actions	Check resmond resource and intenal tables

Log ID	RESMON_BDS_ATTR_OBJ_NOT_FOUND
Message	Unable to get attribute "%s" in "%s"
Description	Resmond bds event logging
Log Module	resmon
Log Group	resmon-bds-events
Severity	DEBUG
Recommended Actions	Check resmond resource and intenal tables

Log ID	RESMON_BDS_TABLE_NOT_FOUND
Message	Table "%s" not present
Description	Resmond bds event logging
Log Module	resmon
Log Group	resmon-bds-events
Severity	DEBUG
Recommended Actions	Check resmond resource and intenal tables

Log ID	RESMON_BDS_TBL_CREATE_ERR
Message	Failed to create table %s of type %s
Description	Resmond bds event logging
Log Module	resmon
Log Group	resmon-bds-events
Severity	DEBUG
Recommended Actions	Check resmond resource and intenal tables

Log ID	RESMON_BDS_TBL_SUBSCRIBE_ERR
Message	Failed to subscribe table %s
Description	Resmond bds event logging
Log Module	resmon
Log Group	resmon-bds-events
Severity	DEBUG
Recommended Actions	Check resmond resource and intenal tables

Log ID	RESMON_INTERNAL_FILE_OPEN_ERR
Message	File %s open failed[%s - %s]
Description	Resmond internal event logging
Log Module	resmon
Log Group	resmon-internal-events
Severity	DEBUG
Recommended Actions	Check resmond resource and intenal tables

Log ID	RESMON_INTERNAL_FILE_CLOSE_ERR
Message	File %s open failed[%s - %s]
Description	Resmond internal event logging
Log Module	resmon
Log Group	resmon-internal-events
Severity	DEBUG
Recommended Actions	Check resmond resource and intenal tables

Log ID	RESMON_INTERNAL_FILE_NOT_FOUND
Message	File %s not found
Description	Resmond internal event logging
Log Module	resmon
Log Group	resmon-internal-events
Severity	DEBUG
Recommended Actions	Check resmond resource and intenal tables

Log ID	RESMON_INTERNAL_CMD_EXEC_FAIL
Message	Failed to execute system cmd[%s], err code[%s]
Description	Resmond internal event logging
Log Module	resmon
Log Group	resmon-internal-events
Severity	DEBUG
Recommended Actions	Check resmond resource and intenal tables

validation Log Messages

Log Level Summary

Debug(33)

Log ID	VALIDATION_TABLE_CREATED
Message	BDS table %s created
Description	BDS table created
Log Module	validation
Log Group	general
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	VALIDATION_TABLE_CREATE_ERROR
Message	Failed to create BDS table %s
Description	Failed to create BDS table
Log Module	validation
Log Group	general
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	VALIDATION_TABLE_DELETED
Message	BDS table %s deleted
Description	BDS table deleted
Log Module	validation
Log Group	general
Severity	debug

Recommended Actions	Contact Rtbrick customer support

Log ID	VALIDATION_TABLE_ATTR_NOT_FOUND
Message	Failed to get table attribute for table %s
Description	BDS table attribute not found
Log Module	validation
Log Group	general
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	VALIDATION_TABLE_NOT_FOUND
Message	Failed to get table %s
Description	BDS table not found
Log Module	validation
Log Group	general
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	VALIDATION_TABLE_SUBSCRIBED
Message	BDS table %s subscribed
Description	BDS table subscribed
Log Module	validation
Log Group	general
Severity	debug

Recommended Actions	Contact Rtbrick customer support

Log ID	VALIDATION_TABLE_UNSUBSCRIBED
Message	BDS table %s unsubscribed
Description	BDS table unsubscribed
Log Module	validation
Log Group	general
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	VALIDATION_TRAP_ADDED
Message	Trap %s added
Description	Validation trap added
Log Module	validation
Log Group	config
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	VALIDATION_TRAP_DELETED
Message	Trap %s deleted
Description	Validation trap deleted
Log Module	validation
Log Group	config
Severity	debug

Recommended Actions	Contact Rtbrick customer support

Log ID	VALIDATION_OBJ_GET_FAILED
Message	Failed to get object for table %s
Description	BDS object get failed
Log Module	validation
Log Group	general
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	VALIDATION_OBJ_ADD_FAILED
Message	Failed to add object for table %s
Description	BDS object add failed
Log Module	validation
Log Group	general
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	VALIDATION_OBJ_DEL_FAILED
Message	Failed to delete object for table %s
Description	BDS object delete failed
Log Module	validation
Log Group	general
Severity	debug

Recommended Actions	Contact Rtbrick customer support

Log ID	VALIDATION_CACHE_ADDED
Message	Cache object added in instance %s with cache-ip %s src-ip %s
Description	Cache object added
Log Module	validation
Log Group	general
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	VALIDATION_CACHE_DELETED
Message	Cache object deleted from instance %s with cache-ip %s src-ip %s
Description	Cache object deleted
Log Module	validation
Log Group	general
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	VALIDATION_CACHE_ADD_FAILED
Message	Failed to add cache object in instance %s with cache-ip %s src-ip %s
Description	Cache object add failed
Log Module	validation
Log Group	general

Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	VALIDATION_CACHE_DEL_FAILED
Message	Failed to delete cache object from instance %s with cache-ip %s src-ip %s
Description	Cache object delete failed
Log Module	validation
Log Group	general
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	VALIDATION_CACHE_CHANGED
Message	Cache object changed in instance %s with cache-ip %s src-ip %s
Description	Cache object changed
Log Module	validation
Log Group	general
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	VALIDATION_CACHE_GET_FAILED
Message	Failed to get cache in instance %s with cache-ip %s src-ip %s
Description	Cache object get failed
Log Module	validation

Log Group	general
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	VALIDATION_CACHE_STOPPED
Message	Cache stopped in instance %s with cache-ip %s src-ip %s
Description	Cache stopped
Log Module	validation
Log Group	general
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	VALIDATION_CACHE_FLUSHED
Message	Cache stale object flushed in instance %s with cache-ip %s src-ip %s
Description	Cache stale object flushed
Log Module	validation
Log Group	general
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	VALIDATION_CACHE_FLUSH_COUNT
Message	%s stale objects flushed in table %s
Description	Cache stale object flushed

Log Module	validation
Log Group	general
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	VALIDATION_CACHE_DATABASE_FLUSH
Message	full table %s flushed
Description	Cache database flushed
Log Module	validation
Log Group	general
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	VALIDATION_CACHE_START
Message	Tring to start the cache in instance %s with cache-ip %s src-ip %s
Description	Cache start
Log Module	validation
Log Group	general
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	VALIDATION_CACHE_CONNECT
Message	Tring to connect to cache in instance %s with cache-ip %s src-ip %s port %s

Description	Cache connect
Log Module	validation
Log Group	general
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	VALIDATION_CACHE_CONNECT_FAILED
Message	Connect failed to cache in instance %s with cache-ip %s src-ip %s port %s
Description	Cache connect failed
Log Module	validation
Log Group	general
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	VALIDATION_PKT_ERROR
Message	Error while processing pdu %s from cache in instance %s with cache-ip %s src-ip %s
Description	Cache packet error
Log Module	validation
Log Group	general
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	VALIDATION_PKT_ERROR_SEND

Message	Sending error %s %s to cache in instance %s with cache-ip %s src-ip %s
Description	Cache packet error
Log Module	validation
Log Group	general
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	VALIDATION_PKT_ERROR_CACHE_NOT_FOUND
Message	Failed to get cache during pkt processing in instance %s with cache-ip %s src-ip %s
Description	Cache object not found
Log Module	validation
Log Group	general
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	VALIDATION_FSM_TIMER_STARTED
Message	Timer %s started for cache in instance %s with cache-ip %s src-ip %s
Description	Cache fsm timer started
Log Module	validation
Log Group	general
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	VALIDATION_FSM_TIMER_STOPPED
Message	Timer %s stopped for cache in instance %s with cache-ip %s src-ip %s
Description	Cache fsm timer stopped
Log Module	validation
Log Group	general
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	VALIDATION_FSM_TIMER_EXPIRED
Message	Timer %s expired for cache in instance %s with cache-ip %s src-ip %s
Description	Cache fsm timer expired
Log Module	validation
Log Group	general
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	VALIDATION_FSM_EVENT
Message	cache [%s cache-ip %s src-ip %s] moved from %s to %s with event %s
Description	Cache fsm timer expired
Log Module	validation
Log Group	general
Severity	debug
Recommended Actions	Contact Rtbrick customer support

Log ID	VALIDATION_LWIP_EVENT
Message	Event %s for cache [%s cache-ip %s src-ip %s]
Description	Cache lwip event
Log Module	validation
Log Group	general
Severity	debug
Recommended Actions	Contact Rtbrick customer support

11.4. LED Control

11.4.1. LED Overview

You can use the switch LEDs to monitor the activity and performance of a network switch or router. Using the LED control functionality, you can control the LEDs that are available in the hardware platforms supported by RBFS.

There are two types of LEDs available in the switch:

- Network Port LEDs
- System LEDs

Supported Platforms

Not all features are necessarily supported on each hardware platform. Refer to the *Platform Guide* for the features and the sub-features that are or are not supported by each platform.

11.4.2. LED Definitions

Port LED Definition for UfiSpace S9500-22XST

The network port LEDs are used to show the status of the link associated with the

LED. In a UfiSpace S9500-22XST switch, there are 12*10G SFP+ ports, 8*25G SFP28 ports, and 2*100G QSFP28 ports on the front panel. The SFP, SFP28, and QSFP28 ports operate in a full duplex mode when the speed is 10Gbps, 25Gbps, or 100Gbps.

LED	Condition	Status
SFP+ Port LED	On (Green)	Link is up
	Off	No link
SFP28 Port LED	On (Green)	Link is up
	Off	No link
QSFP28 Port LED	On (Green)	Link is up
	Off	No link

System LED Definition for UfiSpace S9500-22XST

The system LEDs are used to indicate the status of power and system.

LED Indicators	Condition	Status
Power	Off	No power or in shut down mode.
	Solid Green	System power is good and the BMC heating is complete.
	Blinking Green	System power is good and the BMC heating is in progress.
	Solid Yellow	System power is good but BMC heating is failed.
	Blinking Yellow	System power failure.
STAT (System Status)	Off	System (X86 and BMC) is no booted.
	Solid Green	System boot is complete.
	Blinking Green	System boot is in progress.
	Solid Yellow	Reserved
	Blinking Yellow	Reserved

LED Indicators	Condition	Status
PSU LED Functions and State	Off	No DC power to any of the PSUs.
	Flashing Red	No DC power to this particular PSU.
	Flashing Green	DC is present, only standby output is on. Poor contact.
	Green	PSU DC output is on and is normal.
	Red	PSU failure.
	Flashing between Green and Red	Warning. Working condition is not satisfied. Check the voltage, electric current, and temperature.
FAN LED Functions and State	Off	Main board 3.3V power is failed or fan is not present.
	Solid Green	Fan is present and interrupt de-assert.
	Blinking Green	NA
	Solid Yellow	NA
	Blinking Yellow	Fan is present but interrupt assert.

Port LED Definition for UfiSpace S9600-32X

The network port LEDs are used to show the status of the link associated with the LED. In a UfiSpace S9600-32X switch, there are 4*10G SFP+ ports and 32*100G QSFP28 ports on the front panel. The SFP+ and QSFP28 ports operate in full duplex mode when the speed is 10Gbps and 100Gbps respectively.

LED	Condition	Status
SFP+ Port LED	On (Green)	Link is up
	Off	No link

LED	Condition	Status
QSFP28 Port LED	On (Green)	Link is up
	Off	No link

System LED Definition for UfiSpace S9600-32X

The system LEDs are used to indicate the status of power and system.

LED	Condition	Status
SYS	Off	System (x86 and BMC) is not booted.
	Solid Green	System boot is complete.
	Blinking Green	System boot is in progress.
	Fast Blinking Green	Reserved.
	Solid Amber	Power is up but system boot is failed.
	Blinking Amber	Reserved
	Fast Blinking Amber	Reserved

LED	Condition	Status
FAN	Off	Main board 3.3V_FAN power failure or no power.
	Solid Green	All fans are working normally and interrupt de-assert.
	Blinking Green	Fans PWMs do not match or each one fan no present
	Fast Blinking Green	Reserved.
	Solid Amber	Each one of fans is failure (PWM=0)
	Blinking Amber	Fan is present but interrupt assert.
	Fast Blinking Amber	Reserved
PSU1	Off	No DC power or standby is failed.
	Solid Green	PSU DC output is ON and standby is normal.
	Blinking Green	No PSU is present.
	Fast Blinking Green	Reserved.
	Solid Amber	PSU DC output is failed and standby is normal.
	Blinking Amber	Warning. Working condition is not satisfied. (Check the voltage, electric current, and temperature).
	Fast Blinking Amber	Reserved

LED	Condition	Status
PSU2	Off	No DC power or standby is failed.
	Solid Green	PSU DC output is ON and standby is normal.
	Blinking Green	No PSU is present.
	Fast Blinking Green	Reserved.
	Solid Amber	PSU DC output is failed and standby is normal.
	Blinking Amber	Warning. Working condition is not satisfied. (Check the voltage, electric current, and temperature).
	Fast Blinking Amber	Reserved
ID	Off	Turned off location of function
	Solid Blue	Ready for location of function
	Blinking Blue	Location of switch in telcom center
	Fast Blinking Blue	Reserved.

Port LED Definition for UfiSpace S9600-72XC

The network port LEDs are used to show the status of the link associated with the LED. In an UfiSpace S9600-72XC switch, there are 64*25G SFP28 ports and 8*100G QSFP28 on the front panel. SFP28 and QSFP28 operate in full duplex mode when the speed is 25Gbps and 100Gbps respectively.

LED	Condition	Status
SFP28 Port LED	On (Green)	Link is up
	Off	No link

LED	Condition	Status
QSFP28 Port LED	On (Green)	Link is up
	Off	No link

System LED Definition for UfiSpace S9600-72XC

The system LEDs are used to indicate the status of power and system.

LED	Condition	Status
SYS	Off	No power
	Solid Green	Host CPU/BMC boot is complete
	Solid Amber	Power is up, but host CPU/BMC boot is failed.
FAN	Off	Fans are not initialized.
	Solid Green	All fans are working normally.
	Blinking Amber	Fan is not working. One or more fans need service.
PSU1	Off	No power
	Solid Green	PSU1 is working normally.
	Blinking Amber	PSU1 is failed. Service required.
PSU2	Off	No power
	Solid Green	PSU2 is working normally.
	Blinking Amber	PSU2 is failed. Service is needed.

Port LED Definition for UfiSpace S9510-28DC

The network port LEDs are used to represent the status of the link associated with the LED.

Port type	Condition	Status
SFP+	Up	Green
	Down	Off

Port type	Condition	Status
SFP28	Up	Green
	Down	Off
QSFP28	Up	Green
	Down	Off

System LED Definition for UfiSpace S9510-28DC

The system LEDs are used to indicate the status of power and system.

LED Indicators	Behavior	Status
Power	Off	No power or in shut down mode.
	Solid Green	System power is good.
	Blinking Green	System power is good but BMC power is failed.
	Solid Yellow	System power is good but CPU power is failed.
	Blinking Yellow	System power failure.
STAT (System Status)	Off	System (X86 and BMC) is not booted.
	Solid Green	System boot is complete.
	Blinking Green	System boot is in progress.
	Solid Yellow	System boot is complete. (DIAG OS)
	Blinking Yellow	Reserved

LED Indicators	Behavior	Status
PSU LED Functions and State	Off	No DC power to any of the PSUs.
	Flashing Red	No DC power to this particular PSU.
	Flashing Green	DC is present, only standby output is on. Poor contact.
	Green	PSU output is on and normal.
	Red	PSU failure.
	Flashing between Green and Red	Warning. Working condition is not satisfied. Check the voltage, electric current, and temperature.
FAN LED Functions and State	Off	Main board 3.3V power is failed or fan is not present.
	Solid Green	Fan is present but interrupt assert
	Blinking Green	NA
	Solid Yellow	NA
	Blinking Yellow	Fan is present but interrupt assert.

Port LED Definition for EdgeCore AGR130

The network port LEDs are used to represent the status of the link associated with the LED. In an Accton/EdgeCore AGR130 switch, there are 48*10G SFP+ ports and 6*100G QSFP28 on the front panel, the all SFP/QSFP28 will operate in full duplex mode when the speed is 10Gbps or 100Gbps.

LED	Condition	Status
SFP+ Port LED	On/Flashing Green	Link at 10G, flashing indicates activity
	On/Flashing Amber	Link at 1G, flashing indicates activity
	Off	No link
QSFP28 Port LED in 100G Mode (Port 49 - 54)	On/Flashing Green	Link at 100G, flashing indicates activity
	Off	No link
QSFP28 Port LED in 25G Breakout Mode	On/Flashing Amber	Link at 25G in breakout mode, flashing indicates activity
	Off	No link
QSFP28 Port LED in 40G Mode (Port 49 - 54)	On/Flashing Blue	Link at 40G mode, flashing indicates activity
	Off	No link
QSFP28 Port LED in 10G Breakout Mode	On/Flashing Purple	Link at 10G in breakout mode, flashing indicates activity
	Off	No link

System LED Definition for Edgecore AGR130

The system LEDs are used to indicate the status of power and system.

LED	Condition	Status
PSU1 (Power Supply Status)	Green	Power is operating normally
	Amber	Power supply is present but not powered on or faulty.
	Off	Power supply is not present.

LED	Condition	Status
PSU2 (Power Supply Status)	Green	Power is operating normally
	Amber	Power supply is present but not powered on or faulty.
	Off	Power supply is not present.
Diag (Diagnostic)	Green	System self-diagnostic test is successfully completed.
	Amber	System self-diagnostic test detected a fault.
FAN	Green	System FAN is operating normally
	Amber	Fan tray is present buy system FAN is faulty.
	Off	System is off

Port LED Definition for EdgeCore AGR420

The network port LEDs are used to represent the status of the link associated with the LED.

Port type	Condition	Status
SFP+	Up	Blue LED is on (2 LEDs per port)
	Down	Off
SFP28	Up	Blue LED is on (2 LEDs per port)
	Down	Off
QSFP28	Up	Blue LED is on (2 LEDs per port)
	Down	Off

System LED Definition for Edgecore AGR420

The system LEDs are used to indicate the status of power and system.

LED	Condition	Status
DIAG (Diagnostic)	Green	System self diagnostic test is successfully completed.
	Amber	System self-diagnostic test has detected a fault. (Faulty Fan, thermal, or any interface.)
LOC	Flashing Amber	Flashing by remote management command. Assists technician in finding the right device for service in the rack.
	Off	Not the switch that technician needs to find.
FAN	Green	System fan is working normally.
	Amber	Fan tray is present but system fan is faulty.
	Off	System is off.
PSU0 (power supply status)	Green	The power supply, #0, is working normally.
	Amber	Power is present, but not ON. Power is faulty.
	Off	Power supply is not present.
PSU1 (power supply status)	Green	The power supply, #1, is working normally.
	Amber	Power is present, but not ON. Power is faulty.
	Off	Power supply is not present.

Port LED Definition for Edgecore AGR400

The network port LEDs are used to represent the status of the link associated with the LED.

Port type	Condition	Status
SFP28	Up	Blue LED is on (Single LED per port)
	Down	LED is Off
QSFP28	Up	Blue LED is on (2 LEDs per port)
	Down	LED is Off
QSFP-DD	Up	Not tested
	Down	Not tested

System LED Definition for Edgecore AGR400

The system LEDs are used to indicate the status of power and system.

LED	Condition	Status
DIAG (Diagnostic)	Green	System self diagnostic test is successfully completed.
	Amber	System self-diagnostic test has detected a fault. (Faulty Fan, thermal, or any interface.)
LOC	Flashing Amber	Flashing by remote management command. Assists the technician in finding the right device for service in the rack.
	Off	Not the switch that the technician needs to find.
FAN	Green	System fan is working normally.
	Amber	Fan tray is present but system fan is faulty.
	Off	System is off.

LED	Condition	Status
PSU0 (power supply status)	Green	The power supply, #0, is working normally.
	Amber	Power is present, but not ON. Power is faulty.
	Off	Power supply is not present.
PSU1 (power supply status)	Green	The power supply, #1, is working normally.
	Amber	Power is present, but not ON. Power is faulty.
	Off	Power supply is not present.

Port LED Definition for Edgecore CSR440

The network port LEDs are used to represent the status of the link associated with the LED.

Port type	Condition	Status
10G	Up	Green
	Down	LED is Off
25G	Up	Blue
	Down	LED is Off
100G	Up	Two LEDs per port. Green (on QSFP28) and Violet (on QSFP-DD).
	Down	LED is off

System LED Definition for Edgecore CSR440

The system LEDs are used to indicate the status of power and system.

Port type	Condition	Status
PSU1 (power supply unit)	Solid Green	PSU1 is operating normally.
	Solid Amber	Input power is present, but the PSU1 is not ON or is in a faulty state.
	Off	The input power is not present or PSU1 is not present.
PSU2 (power supply unit)	Solid Green	PSU2 is operating normally.
	Solid Amber	Input power is present, but the PSU2 is not ON or is in a faulty state.
	Off	Input power is not present or PSU2 is not present.
DIAG (Diagnostic)	Solid Green	System self diagnostic test is successfully completed.
	Blinking Green	System self-diagnostic test is in progress.
	Solid Orange	System self-diagnostic test has detected a fault.
FAN	Solid Green	All fan modules are present and working normally.
	Solid Orange	Fan module is present but a fault has been detected.
	Off	Fan module is not present.
LOC	Blinking Blue	Flashing by remote management command. It helps technicians in finding the right device for service in the rack. It provides an indication of the location of the device.
	Off	No indication.
ALARM	Solid Green	No alarms detected.
	Solid Red	Local alarm is detected.

11.5. IPMI

11.5.1. IPMI Overview

The IPMI (Intelligent Platform Management Interface) is an open-standard hardware management interface that allows you communicate with BMC (Baseboard Management Controller) of the platform hardware.

BMC, a dedicated micro-controller, manages the interface between system-management software and platform hardware. BMC performs operations such as remote power on or power off, or makes the console accessible. BMC also monitors the hardware resources such as sensors and can send alert messages over the LAN indicating a potential failure of the system.

IPMI is a way to manage the platform hardware by interacting with the hardware directly rather than with the operating system. The advantages of using IPMI are that it allows an out-of-band platform hardware management and the operating system is not burdened with the operational overheads by sending system status data.

Supported Platforms

Not all features are necessarily supported on each hardware platform. Refer to the *Platform Guide* for the features and the sub-features that are or are not supported by each platform.

11.5.2. IPMI Configuration

Configuration Syntax and Commands

The following sections describe the IPMI configuration syntax and commands.

IPMI Interface Configuration

This configuration allows you to communicate with the BMC on the platform hardware.

Syntax:

set system platform-management ipmi interface <interface-id> <attribute> <value>

Attribute	Description
interface <interface-id>	IPMI channel ID. For UfiSpace switches, the LAN interface ID is 1.
type <lan>	type of network
mode <dhcp|static>	Manually set the static IPv4 address or configure DHCP to receive dynamic IPv4 address.
address-family ipv4 prefix4 <prefix4>	IPv4 prefix
address-family ipv4 gateway-address <gateway-address>	IPv4 address for gateway

Example: IPMI Interface Configuration

```
{
  "ietf-restconf:data": {
    "rtbrick-config:system": {
      "platform-management": {
        "ipmi": {
          "interface": [
            {
              "id": 1,
              "type": "lan",
              "mode": "static",
              "address-family": {
                "ipv4": {
                  "prefix4": "198.51.100.110/24",
                  "gateway-address": "198.51.100.111"
                }
              }
            }
          ]
        }
      }
    }
  }
}
```

IPMI User Configuration

This configuration allows you to change the password of one of the 10 users,

including the admin user.

Syntax:

set system platform-management ipmi user <user-id> <options>

Attribute	Description `
user <user-id>`	User ID. The ipmi user id of the default 'admin' user on UfiSpace switches is 2.
password-plain-text <password-plain-text>	Plain text password
password-encrypted-text <password-encrypted-text>	Encrypted password

Example: IPMI User Configuration

```
{
  "ietf-restconf:data": {
    "rtbrick-config:system": {
      "platform-management": {
        "ipmi": {
          "user": [
            {
              "id": 2,
              "password-encrypted-text": "$21e4946e31b406de98b3077aef03ed5a7"
            }
          ]
        }
      }
    }
  }
}
```

11.5.3. IPMI Operational Commands

IPMI Validation Commands

The IPMI validation commands provide you the IPMI configuration, channel, and user information. Configure the server that connects to the hardware platform. Use the IPMI tool to verify the remote accessibility by the running the following commands on the Linux shell.

Verification of remote access can be performed using the following command:

ipmitool -I lanplus -H <ip address> -U admin -P admin lan print 1

Example for remote access verification

```
supervisor@srv10-tst:~$ ipmitool -I lanplus -H 198.51.100.100 -U admin -P admin
lan print 1
Set in Progress         : Set Complete
Auth Type Support       :
Auth Type Enable        : Callback : MD5
                        : User     : MD5
                        : Operator : MD5
                        : Admin    : MD5
                        : OEM      : MD5
IP Address Source       : Static Address
IP Address              : 198.51.100.100
Subnet Mask             : 255.255.255.128
MAC Address             : e8:c5:7a:8f:78:0d
SNMP Community String   : AMI
IP Header               : TTL=0x40 Flags=0x40 Precedence=0x00 TOS=0x10
BMC ARP Control         : ARP Responses Enabled, Gratuitous ARP Disabled
Gratituous ARP Intrvl   : 0.0 seconds
Default Gateway IP      : 198.51.100.41
Default Gateway MAC     : 00:00:5e:00:01:01
Backup Gateway IP       : 198.51.100.10
Backup Gateway MAC      : 00:00:00:00:00:00
802.1q VLAN ID          : Disabled
802.1q VLAN Priority    : 0
RMCP+ Cipher Suites     : 0,1,2,3,6,7,8,11,12,15,16,17
Cipher Suite Priv Max   : caaaaaaaaaaaXXX
                        :     X=Cipher Suite Unused
                        :     c=CALLBACK
                        :     u=USER
                        :     o=OPERATOR
                        :     a=ADMIN
                        :     O=OEM
Bad Password Threshold  : 0
Invalid password disable: no
Attempt Count Reset Int.: 0
User Lockout Interval   : 0
```

Use the following command to verify the channel information:

sudo ipmitool channel info 1

Example for channel information

```
supervisor@onl>ufi06.q2c.u25.r4.nbg.rtbrick.net:~ $ sudo ipmitool channel info 1
Channel 0x1 info:
  Channel Medium Type   : 802.3 LAN
  Channel Protocol Type : IPMB-1.0
  Session Support       : multi-session
  Active Session Count  : 0
```

```
  Protocol Vendor ID    : 7154
  Volatile(active) Settings
    Alerting            : enabled
    Per-message Auth    : disabled
    User Level Auth     : enabled
    Access Mode         : always available
  Non-Volatile Settings
    Alerting            : enabled
    Per-message Auth    : disabled
    User Level Auth     : enabled
    Access Mode         : always available
```

Use the following command to verify a specific channel information:

sudo ipmitool lan print 1

Example for specific channel information

```
supervisor@onl>ufi06.q2c.u25.r4.nbg.rtbrick.net:~ $ sudo ipmitool lan print 1
Set in Progress         : Set Complete
Auth Type Support       :
Auth Type Enable        : Callback : MD5
                        : User     : MD5
                        : Operator : MD5
                        : Admin    : MD5
                        : OEM      : MD5
IP Address Source       : Static Address
IP Address              : 198.51.100.100
Subnet Mask             : 255.255.255.128
MAC Address             : e8:c5:7a:8f:78:0d
SNMP Community String   : AMI
IP Header               : TTL=0x40 Flags=0x40 Precedence=0x00 TOS=0x10
BMC ARP Control         : ARP Responses Enabled, Gratuitous ARP Disabled
Gratituous ARP Intrvl   : 0.0 seconds
Default Gateway IP      : 198.51.100.41
Default Gateway MAC     : 00:00:5e:00:01:01
Backup Gateway IP       : 198.51.100.10
Backup Gateway MAC      : 00:00:00:00:00:00
802.1q VLAN ID          : Disabled
802.1q VLAN Priority    : 0
RMCP+ Cipher Suites     : 0,1,2,3,6,7,8,11,12,15,16,17
Cipher Suite Priv Max   : caaaaaaaaaaaXXX
                        :     X=Cipher Suite Unused
                        :     c=CALLBACK
                        :     u=USER
                        :     o=OPERATOR
                        :     a=ADMIN
                        :     O=OEM
Bad Password Threshold  : 0
Invalid password disable: no
Attempt Count Reset Int.: 0
User Lockout Interval   : 0
```

Use the following command to verify the user for a channel:

sudo ipmitool user list 1

Example for user per channel

```
supervisor@onl>ufi06.q2c.u25.r4.nbg.rtbrick.net:~ $ sudo ipmitool user list 1
ID  Name     Callin  Link Auth IPMI Msg   Channel Priv Limit
1                    false   false      true       ADMINISTRATOR
2   admin            false   false      true       ADMINISTRATOR
3                    true    false      false      NO ACCESS
4                    true    false      false      NO ACCESS
5                    true    false      false      NO ACCESS
6                    true    false      false      NO ACCESS
7                    true    false      false      NO ACCESS
8                    true    false      false      NO ACCESS
9                    true    false      false      NO ACCESS
10                   true    false      false      NO ACCESS
```

11.6. Inband Management

11.6.1. In-band Management Overview

RBFS is mostly deployed on the RtBrick Host Operating System as a Linux container. The RtBrick Host is only reachable through the out-of-band management interface. In order to use services like NTP, and TACACS, which are run on RtBrick Host, or to use services like ssh, snmpd running in LXC container, one must use an out-of-band management connection. In-band management provides a way to access these services which are running in RtBrick Host and LXC containers via physical traffic ports.

The RBFS creates a Linux kernel interface named inband-mgmt-0 when in-band management is enabled on an instance. The loopback IPs of the in-band instance are then assigned to this Linux interface, and the routes of this instance are downloaded to the LXC container, then to RtBrick Host. Trap rules are installed in the hardware depending on the in-band service enabled.

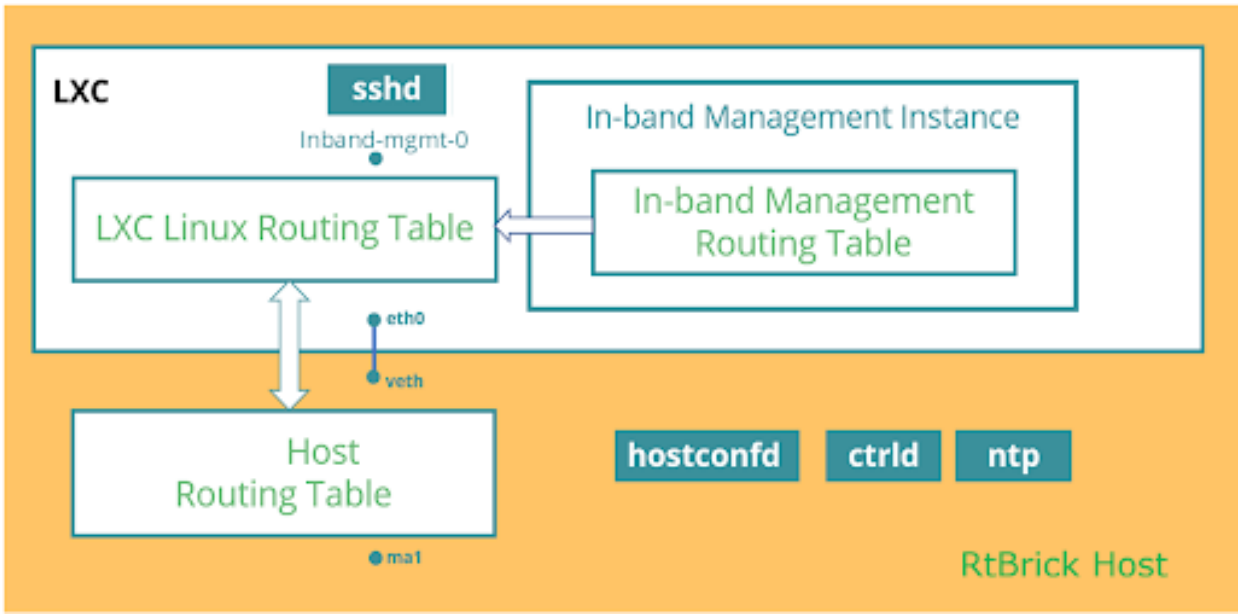


Figure 171. In-band Management Overview

Supported Platforms

Not all features are necessarily supported on each hardware platform. Refer to the *Platform Guide* for the features and the sub-features that are or are not supported by each platform.

11.6.2. In-band Management Configuration

Enabling In-band Management in an Instance

Use the following CLI syntax to enable in-band management in an instance:

set inband-management instance <instance-name>

Attribute	Description
<instance-name>	Routing instance name in which in-band management has to be enabled. All the IFLs in this instance will be enabled with in-band management service after executing this command

The following example configures the management instance in which in-band management will be enabled:

```
set inband-management instance management
```

The following example shows in-band management in an instance:

```
    "rtbrick-config:inband-management": {
      "instance": [
        {
          "name": "management",
        }
      ]
    }
```

API To access the RESTCONF API that corresponds to this CLI, click here.

Enabling In-band Management Services

Syntax:

set inband-management instance <instance-name> <service> <true/false>

Attribute	Description `
<instance-name>`	Routing instance name in which in-band management has to be enabled. All the IFLs in this instance will be enabled with in-band management service after executing this command
<service>	Specifies the supported services to enable: apigw, ctrld, ntp, snmp, ssh, tacacs, telnet. By enabling any of these services, hosts reachable via the physical interface in the inband instance can access the services.
<true | false>	A true value enables the service. A false value disables the service.

Example: Enabling In-band Management Services

```
    "rtbrick-config:inband-management": {
      "instance": [
        {
          "name": "management",
          "ssh": "true",
          "ctrld": "true"
```

```
      }
    ]
  }
```

Enabling API Gateway (APIGW) Service

To access the APIGW service running in the RtBrick Host, this service has to be enabled in in-band management.

Syntax:

set inband-management instance <instance-name> **apigw** <true/false>

Attribute	Description
<instance-name>	Routing instance name in which in-band management has to be enabled.
<true | false>	A true value enables the APIGW service. A false value disables the APIGW service.

Example: Enabling APIGW In-band Management Services

```
  "rtbrick-config:inband-management": {
    "instance": [
      {
        "name": "management",
        "apigw": "true",
      }
    ]
  }
```

Enabling CTRLD Service

To access the CTRLD service running in the RtBrick Host, the CTRLD service has to be enabled in in-band management.

Syntax:

set inband-management instance <instance-name> **ctrld** <true/false>

Attribute	Description
<instance-name>	Routing instance name in which in-band management has to be enabled.
<true | false>	A true value enables the CTRLD service. A false value disables the CTRLD service.

Example: Enabling CTRLD In-band Management Services

```
"rtbrick-config:inband-management": {
  "instance": [
    {
      "name": "management",
      "ctrld": "true",
    }
  ]
}
```

Enabling NTP service

To access the NTP service running in the RtBrick Host, this service has to be enabled in in-band management.

Syntax:

set inband-management instance <instance-name> **ntp** <true/false>

Attribute	Description
<instance-name>	Routing instance name in which in-band management has to be enabled.
<true | false>	A true value enables the ntp service. A false value disables the ntp service.

Example: Enabling NTP In-band Management Services

```
"rtbrick-config:inband-management": {
  "instance": [
    {
      "name": "management",
      "ntp": "true",
    }
  ]
```

```
    }
```

Enabling SNMP service

To access the Simple Network Management Protocol (SNMP) service running in the RtBrick Host, this service has to be enabled in in-band management.

Syntax:

set inband-management instance <instance-name> **snmp** <true/false>

Attribute	Description
<instance-name>	routing instance name in which in-band management has to be enabled.
<true | false>	A true value enables the SNMP service. A false value disables the SNMP service.

Example: Enabling SNMP In-band Management Services

```
    "rtbrick-config:inband-management": {
      "instance": [
        {
          "name": "management",
          "snmp": "true",
        }
      ]
    }
```

Enabling SSH service

To access the ssh service running in the LXC container hosting RBFS, ssh service has to be enabled.

Syntax:

set inband-management instance <instance-name> **ssh** <true/false>

Attribute	Description
<instance-name>	Routing instance name in which in-band management has to be enabled.
<true | false>	A 'true' value enables the ssh service. A 'false' value disables the ssh service.

Example: Enabling SSH In-band Management Services

```
"rtbrick-config:inband-management": {
  "instance": [
    {
      "name": "management",
      "ssh": "true",
    }
  ]
}
```

Enabling TACACS Service

To access the TACACS service running in the RtBrick Host, this service has to be enabled in in-band management.

Syntax:

set inband-management instance <instance-name> **tacacs** <true/false>

Attribute	Description
<instance-name>	Routing instance name in which in-band management has to be enabled.
<true | false>	A true value enables the TACACS service. A false value disables the TACACS service.

Example: Enabling TACACS In-band Management Services

```
"rtbrick-config:inband-management": {
  "instance": [
    {
      "name": "management",
      "tacacs": "true",
    }
  ]
```

```
    }
```

Enabling Telnet Service

To access the telnet service running in the LXC container hosting RBFS, telnet service has to be enabled.

Syntax:

set inband-management instance <instance-name> **telnet** <true/false>

Attribute	Description
<instance-name>	Routing instance name in which in-band management has to be enabled.
<true | false>	A 'true' value enables the telnet service. A 'false' value disables the telnet service.

Example: Enabling Telnet In-band Management Services

```
  "rtbrick-config:inband-management": {
    "instance": [
      {
        "name": "management",
        "telnet": "true",
      }
    ]
  }
```

Enabling Connection Tracking

Enabling connection tracking in inband installs dynamic ACLs for all the connection/packet initiated by the device so that the response packets are not dropped at the hardware.

Syntax:

set inband-management instance <instance-name> **connection-tracking true**

Attribute	Description
<instance-name>	Routing instance name in which in-band management has to be enabled.
true	Enables all in-band management services.

Example: Enabling Connection Tracking in In-band Management

```
"rtbrick-config:inband-management": {
    "instance": [
      {
        "name": "default",
        "connection-tracking": "true"
      }
    ]
  }
```

Enabling LIX1 Service

To enable or disable the "lix1" service within inband management, use the following CLI command:

set inband-management instance <instance-name> **lix1** <true | false>

Attribute	Description
<instance-name>	Specifies the routing instance where the in-band lix1 service is to be enabled.
<true | false>	Setting this attribute to "true" enables the "lix1" service, while setting it to "false" disables the service.

Example: Enabling the "lix1" service in inband management

```
    "rtbrick-config:inband-management": {
      "instance": [
        {
          "name": "default",
          "lix1": "true",
        }
      ]
    }
```

Enabling All Services in In-band Management

Enabling this service will allow access to all services running in LXC/RtBrick Host. Once this service is enabled, packets that don't hit any of the other acls/services in RBFS are redirected to LXC/RtBrick Host.

Syntax:

set inband-management instance <instance-name> **all true**

Attribute	Description
<instance-name>	Routing instance name in which in-band management has to be enabled.
true	Enables all in-band management services.

Example: Enabling all In-band Management Services

```
"rtbrick-config:inband-management": {
  "instance": [
    {
      "name": "management",
      "all": "true",
    }
  ]
}
```

Enabling In-band Management for a Specific Source

Enabling any of the in-band services as mentioned in the previous section will expose this service to all the sources which are reachable via in-band service.

To restrict this to specific source prefixes, source-prefix-list has to be enabled using the following command.

By configuring this, the hosts having IPs in the mentioned source prefix list only can access this service.

Syntax:

set inband-management instance <instance-name> **source-prefix-list**

```
<source-prefix-list-name>
```

Attribute	Description
<instance-name>	Routing instance name in which in-band management has to be enabled.
<source-prefix-list-name>	Specifies the name of the source prefix-list which is configured with set forwarding-options prefix-list command.

Example: Enabling source prefix list in In-band Management Services

```
    "rtbrick-config:inband-management": {
      "instance": [
        {
          "name": "management",
          "source-prefix-list": "source-prefix1"
        }
      ]
    }
```

11.6.3. In-Band Management Operational Commands

The In-band Management show commands provide detailed information about the In-band Management operations.

Verifying In-band Management on LXC Container

In the LXC container, there will be a new interface named inband-mgmt-0 on enabling in-band management. All the loopback address as well as route in in-band instance should be assigned to this interface.

The example below shows how to verify if inband-mgmt-0 interface is created. Using the following command check if inband-mgmt-0 interface is created.

```
supervisor@rtbrick:~$ ip link show
<...>
5: inband-mgmt-0: <POINTOPOINT,UP,LOWER_UP> mtu 1492 qdisc pfifo_fast state
UNKNOWN mode DEFAULT group default qlen 500
    link/none
```

Now verify that all the loopback addresses in the in-band management instance are added to Linux:

```
3: inband-mgmt-0: <POINTOPOINT,UP,LOWER_UP> mtu 1492 qdisc pfifo_fast state
UNKNOWN group default qlen 500
    link/none
    inet 192.0.2.1/32 scope global inband-mgmt-0
       valid_lft forever preferred_lft forever
    inet 198.51.100.1/32 scope global inband-mgmt-0
       valid_lft forever preferred_lft forever
    inet6 fe80::d5c5:38ad:93c:308b/64 scope link stable-privacy
       valid_lft forever preferred_lft forever
<...>
```

Verify all the routes in the same instance are also downloaded:

```
supervisor@rtbrick:~$ ip route show
<...>
192.0.2.0/24 dev inband-mgmt-0 proto rtb_fibd scope link
192.0.2.1 dev inband-mgmt-0 proto rtb_fibd scope link
198.51.100.0/24 dev inband-mgmt-0 proto rtb_fibd scope link
198.51.100.1 dev inband-mgmt-0 proto rtb_fibd scope link
```

Verifying In-band Management on RtBrick Host

The example below shows how to verify Linux routing tables on the Host Operating System and an LXC container. The same routes downloaded into the LXC container should also be present in RtBrick Host.

```
root@bl2-pod1:~# ip route show
<...>
192.0.2.0/24 via 10.0.3.10 dev lxcbr0 proto rtb_routesync scope rtb_umc metric 128
192.0.2.1 via 10.0.3.10 dev lxcbr0 proto rtb_routesync scope rtb_umc metric 128
198.51.100.0/24 via 10.0.3.10 dev lxcbr0 proto rtb_routesync scope rtb_umc metric
128
198.51.100.1 via 10.0.3.10 dev lxcbr0 proto rtb_routesync scope rtb_umc metric 128
```

11.7. DHCP Relay/Proxy

11.7.1. DHCP Relay Overview

The Dynamic Host Configuration Protocol (DHCP) is a standardized client/server network protocol that dynamically assigns IPv4 addresses and other related configuration information to network devices.

DHCP provides an automated way to distribute and update IPv4 addresses and other configuration information on a network. A DHCP server provides this information to a DHCP client through the exchange of a series of messages, known

as the DHCP conversation or the DHCP transaction. If the DHCP server and DHCP clients are located on different subnets, a DHCP relay agent is used to facilitate the conversation.

The RBFS DHCP relay agent handles all DHCP packets received on logical interfaces with the relay agent functionality enabled. This includes all DHCP broadcast and unicast packets to ensure that the whole DHCP communication between client and server can be tracked for operational and security reasons. The DHCP packets received from clients will than be forwarded to one or more DHCP servers to support high availability.

All DHCP packets send from the relay agent to the configured DHCP servers will be send with the IP address of the gateway interface (giaddr) or a dedicated source address per server. This allows to better traverse firewalls between relay agent and server.

Supported Platforms

Not all features are necessarily supported on each hardware platform. Refer to the *Platform Guide* for the features and the sub-features that are or are not supported by each platform.

DHCP Relay Agent

The following are the operation steps involved by the DHCP relay agent with multiple clients and servers:

1. DHCP client sends DISCOVER packets onto the LAN.
2. DHCP relay agent receives the DISCOVER packet, creates a client binding and forwards it to the configured server(s) in different subnets.
3. DHCP server replies with OFFER packet.
4. DHCP relay agent on receiving the OFFER, sends it to the client based on the binding.
5. DHCP client sends a REQUEST after receiving the OFFER.
6. DHCP relay agent forwards the REQUEST to the configured server(s).
7. Selected DHCP server replies to the REQUEST with an ACK.
8. DHCP relay agent receives the ACK and forward it to client.

9. Client will start using the IP and configuration after receiving the ACK.
10. DHCP relay agent listen to the unicast communication between the client and server and update the bindings.

DHCP Relay in Proxy Mode

The proxy mode is an enhancement for the DHCP relay function to hide and protect the actual DHCP servers from the clients. For servers this mode is transparent but for clients it seems that the relay agent is the server and the actual servers are not visible anymore.

The following are the operation steps involved by the DHCP relay agent in proxy mode with multiple clients and servers:

1. DHCP client sends DISCOVER packets onto the LAN.
2. DHCP relay agent receives the DISCOVER packet, creates a client binding and forwards it to the configured server(s) in different subnets.
3. DHCP server replies with OFFER packet.
4. DHCP relay agent on receiving OFFERs from multiple servers, select the OFFER from the first server, replaces the server identifier with relay agent address, update the binding and sends it to the client.
5. DHCP client sends a REQUEST to relay agent address after receiving the OFFER.
6. DHCP relay agent forwards the REQUEST to the configured server(s).
7. Selected DHCP server replies to the REQUEST with an ACK.
8. DHCP relay agent receives the ACK, replaces the server identifier with relay agent address and forward it to client.
9. Client will start using the IP and configuration after receiving the ACK.
10. Client request the relay agent for the lease renewals, which relay agent will forward to the selected server.

In all the steps above, the client remains unaware of the actual DHCP server.

11.7.2. DHCP Relay Configuration

DHCP relay requires a pre-provisioned logical interface with at least an local or borrowed (unnumbered) IPv4 address configured which is than used a gateway IP

address (giaddr) by the DHCP relay function.

There are two steps required to enable the DHCP relay functionality:

1. DHCP server configuration
2. DHCP relay configuration

DHCP Server Configuration

This configuration defines the DHCP servers which are referenced by the actual DHCP relay configuration.

```
supervisor@rtbrick>LEAF01: cfg> set access dhcp-server <server>
  <cr>
  address               DHCP server address
  routing-instance      Instance name from which DHCP server is reachable
  source-address        Source address used for DHCP packets
```

The following example shows a typical DHCP server configuration.

```
{
  "rtbrick-config:access": {
    "dhcp-server": [
      {
        "server-name": "server1",
        "address": "198.51.100.101",
        "routing-instance": "default"
      }
    ]
  }
}
```

Attribute	Description
server	Specifies the DHCP server name.
address	Specifies the IPv4 address of the DHCP server.
routing-instance	Routing instance from which DHCP server is reachable. **Default:** default
source-address <source-address>	Specifies the source IPv4 address to be used to reach DHCP server. **Default:** gateway interfaces address (giaddr)

DHCP Relay Configuration

This configuration enables the DHCP relay function on the corresponding logical interface (IFL).

```
supervisor@rtbrick>LEAF01: cfg> set access dhcp-relay <interface-name>
  <cr>
  agent-circuit-id      Add Agent-Circuit-Id (option 82)
  agent-remote-id       Add Agent-Remote-ID (option 82)
  dhcp-server           DHCP server
  proxy-mode            Enable relay proxy mode
```

The following example shows a typical DHCP relay configuration.

```
{
    "rtbrick-config:access": {
      "dhcp-relay": [
        {
          "interface": "ifl-0/0/1/1",
          "dhcp-server": [
            "server1",
            "server2"
           ]
        }
      ]
    }
  }
```

Attribute	Description
interface-name	Logical interface name on which client packets are expected.
dhcp-server <dhcp-server>	DHCP server name to which client packets has to be forwarded (multiple servers can be configured).
proxy-mode	Enable the relay proxy mode for this interface.
agent-circuit-id <aci>	Agent-Circuit-Id to be added in DHCP option 82.
agent-remote-id <ari>	Agent-Remote-Id to be added in DHCP option 82.

DHCP Relay on Unnumbered Interface

DHCP Relay is supported over unnumbered interfaces. The configuration is similar to the regular DHCP relay configuration. The only change is that the logical interface will have a borrowed IP address.

The following example shows a typical DHCP relay configuration over unnumbered interface.

```
{
  "data": {
    "rtbrick-config:interface": [
      {
        "name": "ifp-0/0/1",
        "unit": [
          {
            "unit-id": 1,
            "unnumbered": {
              "interface": "lo-0/0/1/1"
            }
          }
        ]
      },
      {
        "name": "ifp-0/0/2",
        "unit": [
          {
            "unit-id": 1,
            "unnumbered": {
              "interface": "lo-0/0/1/1"
            }
          }
        ]
      },
      {
        "name": "lo-0/0/1",
        "unit": [
          {
            "unit-id": 1,
            "address": {
              "ipv4": [
                {
                  "prefix4": "198.51.100.71/24"
                }
              ]
            }
          }
        ]
      }
    ],
    "rtbrick-config:access": {
      "dhcp-relay": [
        {
          "interface": "ifl-0/0/1/1",
          "dhcp-server": [
            "server1",
            "server2"
            ]
        },
        {
          "interface": "ifl-0/0/2/1",
          "dhcp-server": [
            "server1",
            "server2"
            ]
```

```
        }
      ]
    }
  }
}
```

11.7.3. DHCP Relay Operational Commands

Verify DHCP Relay Configuration

A good starting point for any troubleshooting is to get an overview about the configuration.

First check the DHCP server configuration and optionally check the reachability using additional commands like ping.

```
supervisor@rtbrick>LEAF01: cfg> show config access dhcp-server
{
    "rtbrick-config:dhcp-server": [
      {
        "server-name": "server1",
        "address": "198.51.100.15",
        "source-address": "198.51.100.101",
        "routing-instance": "default"
      }
    ]
  }
```

In the next step it should be verified that the DHCP relay function is enabled for the desired logical interfaces. Those interfaces must be configured with a valid local or borrowed (unnumbered) IPv4 address.

```
supervisor@rtbrick>LEAF01: cfg> show config access dhcp-relay
{
    "rtbrick-config:dhcp-relay": [
      {
        "interface": "ifl-0/0/1/1",
        "dhcp-server": [
          "server1",
          "server2"
          ]
      }
    ]
  }
```

Verify DHCP Relay Packet Processing

All DHCP packets processed by RBFS will be handled by the IPoE daemon (rtbrick-

ipoed.1) which separates between DHCP relay and subscriber packets.

The command show dhcp statistics gives some statistics about the DHCP packets send and received by the IPoE daemon.

```
supervisor@rtbrick>LEAF01: op> show dhcp statistics
Packets received            : 0
Decode error                : 0
Relay packets received      : 0
Relay packets sent          : 0
Relay send error            : 0
Subscriber packets received : 0
Subscriber packets sent     : 0
Subscriber send error       : 0
```

Received malformed packets will be counted here as part of the shared DHCP packet infrastructure.

Those statistics can be reset with the command clear dhcp statistics.

In the next step, the command show dhcp relay statistics provides more detailed statistics for those packets handled by the DHCP relay function.

```
supervisor@rtbrick>LEAF01: op> show dhcp relay statistics
Packet           Received         Sent
DHCP DISCOVER  : 0                0
DHCP OFFER     : 0                0
DHCP REQUEST   : 0                0
DHCP DECLINE   : 0                0
DHCP ACK       : 0                0
DHCP NAK       : 0                0
DHCP RELEASE   : 0                0
DHCP INFORM    : 0                0

Errors:

Invalid client packets received : 0
Invalid server packets received : 0
I/O errors                      : 0
Configuration errors            : 0
```

A DHCP packet is consider as invalid if correctly formed but some invalid or unexpected values like a DHCP hop count greater than 16, messages from server without server identifier option, non-matching transaction (XID) and many more.

Those statistics can be reset with the command clear dhcp relay statistics.

Verify DHCP Relay Bindings

The DHCP relay function tracks all active DHCP communications as so called bindings. The command show dhcp relay binding allows to verify those bindings with extensive filters to better navigate in scaled environments with thousands of bindings.

```
supervisor@rtbrick>LEAF01: op> show dhcp relay binding ?
  <cr>
  detail                Detailed binding information
  filter                Filter DHCP relay binding
  interface             Interface
```

```
supervisor@rtbrick>LEAF01: op> show dhcp relay binding filter ?
  address               Client IP address
  count                 Count matching bindings
  detail                Detailed binding information
  interface             Interface
  interface-regex       Interface regex
  mac                   Hardware address
  mac-regex             Hardware address regex
  server                Server identifier
```

```
supervisor@rtbrick>LEAF01: op> show dhcp relay binding detail
Interface                   : ifp-0/0/1/3
Hardware Address            : 02:00:00:00:00:01
Client IP Address           : 198.51.100.58
Routing Instance            : default
Proxy Mode                  : enabled
Server Identifier           : 198.51.100.15
Gateway IP Address          : 198.51.100.35
Lease Time                  : 120.0 sec
Lease Start                 : Tue Nov 16 22:27:15 GMT +0000 2021
Lease Expires               : 66.0 sec
Last Packet Received        : Tue Nov 16 22:27:15 GMT +0000 2021
Last Received Packet Type   : ACK
Last Packet Sent            : Tue Nov 16 22:27:15 GMT +0000 2021
Last Sent Packet Type       : ACK
```

The most extensive output is provided by selecting a particular binding using the interface and client MAC address as key.

```
supervisor@rtbrick>LEAF01: op> show dhcp relay binding interface ifp-0/0/1/3 mac 02:00:00:00:00:01
Interface                 : ifp-0/0/1/3
Hardware Address          : 02:00:00:00:00:01
Client IP Address         : 198.51.100.58
Routing Instance          : default
Proxy Mode                : enabled
Server Identifier         : 198.51.100.15
Gateway IP Address        : 198.51.100.35
Lease Time                : 120.0 sec
Lease Start               : Tue Nov 16 22:31:15 GMT +0000 2021
```

```
Lease Expires              : 104.0 sec
Last Packet Received       : Tue Nov 16 22:31:15 GMT +0000 2021
Last Received Packet Type  : ACK
Last Packet Sent           : Tue Nov 16 22:31:15 GMT +0000 2021
Last Sent Packet Type      : ACK

Statistics:

Packet           Received         Sent
DHCP DISCOVER  : 1                1
DHCP OFFER     : 1                1
DHCP REQUEST   : 36               36
DHCP DECLINE   : 0                0
DHCP ACK       : 36               36
DHCP NAK       : 0                0
DHCP RELEASE   : 0                0
DHCP INFORM    : 0                0

Errors:

Invalid client packets received : 0
Invalid server packets received : 0
I/O errors                      : 0
Configuration errors            : 0
```

This output returns additional statistics per DHCP relay binding.

The command clear dhcp relay binding removes either all bindings, all bindings of a corresponding interface or only one particular binding.

```
supervisor@rtbrick>LEAF01: op> clear dhcp relay binding ?
  all                   Clear all DHCP relay bindings
  interface             Interface
```

```
supervisor@rtbrick>LEAF01: op> clear dhcp relay binding all
supervisor@rtbrick>LEAF01: op> clear dhcp relay binding interface ifp-0/0/1/3
supervisor@rtbrick>LEAF01: op> clear dhcp relay binding interface ifp-0/0/1/3 mac
02:00:00:00:00:01
```

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