



OSPF User Guide

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1. Introduction to OSPF

Open Shortest Path First (OSPF) is an interior gateway protocol (IGP) that routes packets within a single autonomous system (AS). OSPF uses link-state information to make routing decisions, making route calculations using the shortest-path-first (SPF) algorithm. Like all link-state protocols, OSPF is very efficient in its use of network bandwidth.

1.1. Supported OSPF Standards

RtBrick FullStack (RBFS) substantially supports the following RFCs, which define standards for OSPF and OSPF version 2 (OSPFv2).

- RFC 2328, OSPF Version 2
- RFC 8665, OSPF Extensions for Segment Routing

1.2. Supported OSPF Features

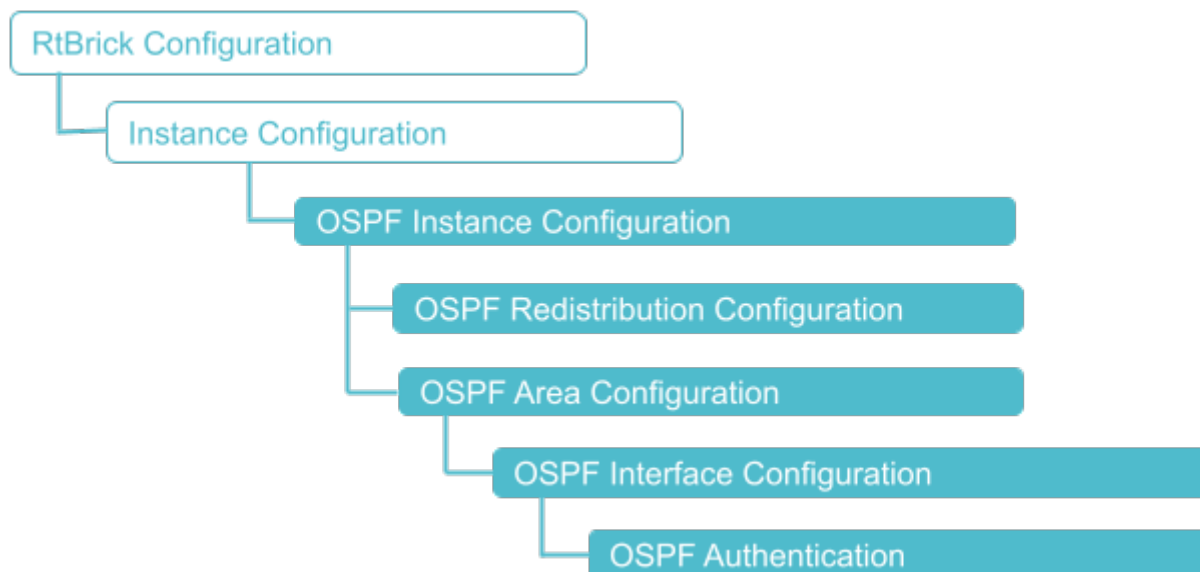
The RBFS implementation conforms to the OSPF Version 2 specifications detailed in the RFC 2328. The following list outlines the key features supported in the RBFS OSPF implementation:

- Stub areas—The definition of stub areas is supported.
- Route redistribution—Routes learned via any IP routing protocol can be redistributed into any other IP routing protocol.
- Authentication—Plain text (simple) and message-digest algorithm 5 (MD5) authentication among neighboring routers within an area is supported.
- Routing interface parameters—Configurable parameters supported include opaque-capability, router priority, segment-routing, sid-index, router “dead” and hello intervals, and authentication key.

2. Configuring OSPF

2.1. 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 which are generic to the respective OSPF instance. The sub-hierarchies include parameters which are specific to redistribution or authentication.



2.2. Configuration Syntax and Commands

The following sections describe the OSPF configuration syntax and commands.

2.2.1. OSPF Instance Configuration

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

Syntax

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

Attribute	Description
area <area-id>	Identifier of an OSPF area. The area-id argument can be specified in IP address format.
area-type <stub totally_stub>	Defines an area type such as stub or totally_stub

Attribute	Description
default-metric <metric>	OSPF interface metric
max-load-balance <max-load-balance>	The maximum number of equal-cost routes for load balancing.
opaque-capability <true / false>	Enable or disable opaque LSA advertisement and reception.
redistribute <source>	Enable the redistribution feature to dynamically inject specific types of routes into the OSPF protocol. Supported route sources are bgp, direct, static, and isis.
router-id <ipv4-address>	The router ID of the routing instance. The router-id configuration is mandatory since RBFS does not pick router-id from device interfaces.
segment-routing <true / false>	Enable or disable segment routing forwarding in OSPF.
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
srgb range <value>	Segment Routing Global Block (SRGB) label range

Example: OSPF Instance Configuration

The following example shows some global OSPF instance configuration attributes.

```

supervisor@rtbrick: cfg> show config instance default
{
  "rtbrick-config:instance": {
    "name": "default",
    "protocol": {
      "ospf": {
        "router-id": "2.2.2.2",
        "opaque-capability": "true",
        "segment-routing": "true",
        "srgb": {
          "base": 1000,
          "range": 1000
        },
        "area": [
          {
            "area-id": "0.0.0.0",
            "interface": [
              {
                "interface-name": "ifl-0/1/2/1"
              },
              {
                "interface-name": "ifl-0/2/3/1"
              },
              {
                "interface-name": "ifl-1/1/2/1"
              }
            ]
          }
        ]
      }
    }
  }
}

```

2.2.1.1. OSPF Redistribution

Enable the redistribution feature to dynamically inject specific types of routes into the OSPF protocol. Supported route sources are bgp, direct, static, and isis.

Syntax

set instance <instance-name> **ospf redistribute** <attribute> <value>

Attribute	Description
bgp <true / false>	Distributes routes from the BGP protocol.
Direct <true / false>	Distributes routes from the directed-attached gateway redundancy (DAGR)
isis <true / false>	Distributes routes from the IS-IS protocol.
static <true / false>	Distributes IP static routes.

Example: Redistribution Configuration

TBD

2.2.2. OSPF Area Configuration

Area number used to define the particular area.

set instance <instance-name> **protocol ospf area** <area-id> **interface** <interface-name>

Attribute	Description
<instance-name>	Name of the OSPF instance
<area-id>	Area number used to define the particular area
<interface-name>	Name of the interface

Example: Interface Area Configuration

```

supervisor@fwdd-r2: cfg> show config instance default protocol ospf area
0.0.0.0
{
  "rtbrick-config:area": {
    "area-id": "0.0.0.0",
    "interface": [
      {
        "interface-name": "memif-0/1/2/1"
      },
      {
        "interface-name": "memif-0/2/3/1"
      },
      {
        "interface-name": "memif-1/1/2/1"
      }
    ]
  }
}
supervisor@fwdd-r2: cfg>

```

2.2.3. OSPF Interface Configuration

Syntax:

set instance <instance-name> **protocol ospf area** <area-id> **interface** <interface-name> <attribute> <value>

Attribute	Description
<instance-name>	Name of the OSPF instance
<interface-name>	Name of the interface

Attribute	Description
<metric-value>	Specify the cost of an OSPF interface
network-type <broadcast p2p>	broadcast - Sets the network type to broadcast; p2p - Sets the network type to point-to-point.
dr-priority <dr-priority>	Sets the router priority for an interface.
sid-index <sid-index>	Specifies the prefix segment identifier (SID) index on the OSPF-enabled interface
dead <dead>	Specifies the length of time, in seconds, that the routing device waits before declaring that a neighboring routing device is unavailable. The range is 1 through 65,535 seconds.
hello <hello>	Specifies the length of time, in seconds, before the routing device sends a hello packet out of an interface. The range is from 1 through 255 seconds.

Example: Interface Area Configuration

```

supervisor@fwdd-r2: cfg> show config instance default protocol ospf area
0.0.0.0 interface if1-0/1/2/1
{
  "rtbrick-config:interface": {
    "interface-name": "if1-0/1/2/1"
  }
}
supervisor@fwdd-r2: cfg>

```

2.2.4. OSPF Authentication

OSPF supports the following two types of authentication:

- MD5 authentication
- Simple authentication

The authentication is accomplished by the exchange of an authenticating key that is known by both the sending and receiving router.

2.2.4.1. OSPF MD5 authentication

This command enables you to set Message Digest 5 (MD5) authentication for an OSPF interface.

set instance <instance-name> **protocol ospf area** <area-id> **interface** <interface-name> **authentication md5 key_id** <key_id> **password** <password>

Attribute	Description
<instance-name>	Name of the OSPF instance
<area-id>	Area number used to define the particular area
<interface-name>	Name of the interface
<key_id>	Specifies a key ID.
<password>	Specifies the password to be used by neighboring routers that are using the OSPF md5 password authentication

Example: Interface Authentication MD5 Configuration

```

supervisor@fwdd-r1: cfg> show config instance red protocol ospf area 0.0.0.0
interface if1-0/0/1/1 authentication type md5
{
  "data": {
    "rtbrick-config:instance": [
      {
        "name": "red",
        "protocol": {
          "ospf": {
            "redistribute": {
              "direct": "true"
            },
            "area": [
              {
                "area-id": "0.0.0.0",
                "interface": [
                  {
                    "interface-name": "if1-0/0/1/1",
                    "authentication": {
                      "type": "md5",
                      "key-id": 1,
                      "encrypted-text": "$2bae0eaf367ec906a2fa325496c6485fb"
                    }
                  }
                ]
              }
            ]
          }
        }
      }
    ]
  }
}
supervisor@fwdd-r1: cfg>

```

2.2.4.2. OSPF Simple Authentication

This command enables you to set simple authentication for an OSPF interface.

set instance <instance-name> **protocol ospf area** <area-id> **interface** <interface-name> **authentication simple password** <password>

Attribute	Description
<instance-name>	Name of the OSPF instance
<area-id>	Area number used to define the particular area
<interface-name>	Name of the interface
<password>	Specifies the password to be used by neighboring routers that are using the OSPF simple password authentication

Example: Interface Authentication Simple Configuration

```

supervisor@fwdd-r1: cfg> show config instance red protocol ospf area 0.0.0.0
interface lo-0/0/1/1 authentication plain-text abcd123
{
  "data": {
    "rtbrick-config:instance": [
      {
        "name": "red",
        "protocol": {
          "ospf": {
            "area": [
              {
                "area-id": "0.0.0.0",
                "interface": [
                  {
                    "interface-name": "ifl-0/0/1/1",
                    "authentication": {
                      "key-id": 1,
                      "encrypted-text": "$2bae0eaf367ec906a2fa325496c6485fb"
                    }
                  }
                ]
              }
            ]
          }
        }
      }
    ]
  }
}
supervisor@fwdd-r1: cfg>

```

3. OSPF Operational Commands

3.1. OSPF Show Commands

3.1.1. OSPF Summary

Displays the OSPF summary information.

Syntax:

show ospf summary <option>

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

Example: OSPF summary for the default instance

```

supervisor@fwdd-r2: op> show ospf summary
Instance: default
  General information
    Router ID: 2.2.2.2, Flags: -|-|-|-
    Flood interval: 3000, Area count: 1,
    Opaque capability: True
    Segment routing capability: True
    SRGB base: 1000
    SRGB range: 1000
    SRGB label values: 1000 - 1999
  Area: 0.0.0.0
    Interface count: 3
    Interface: memif-0/1/2/1
      Address: 10.1.1.2, Cost: 1, State: DR
      Type: broadcast, MTU: 1500, Priority: 1
      Designated Router: 10.1.1.2, Backup Designated Router: 10.1.1.1
      Timers
        Hello interval: 10 sec, Dead interval: 40 sec
    Interface: memif-0/2/3/1
      Address: 30.1.1.2, Cost: 1, State: Backup
      Type: broadcast, MTU: 1500, Priority: 1
      Designated Router: 30.1.1.3, Backup Designated Router: 30.1.1.2
      Timers
        Hello interval: 10 sec, Dead interval: 40 sec
    Interface: memif-1/1/2/1
      Address: 20.1.1.2, Cost: 1, State: DR
      Type: broadcast, MTU: 1500, Priority: 1
      Designated Router: 20.1.1.2, Backup Designated Router: 20.1.1.1
      Timers
        Hello interval: 10 sec, Dead interval: 40 sec
<....>

```

3.1.2. OSPF Interface

Displays OSPF information specific to interfaces.

Syntax:

show ospf interface <option>

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

Example: OSPF interface information for the default instance

```

supervisor@fwdd-r2: op> show ospf interface
Instance: default
  Interface          Area          IP Address    State      Type      Cost
Priority DR          BDR          MTU
  memif-0/1/2/1     0.0.0.0      10.1.1.2     DR         broadcast 1
1      10.1.1.2      10.1.1.1     1500
  memif-0/2/3/1     0.0.0.0      30.1.1.2     Backup     broadcast 1
1      30.1.1.3      30.1.1.2     1500
  memif-1/1/2/1     0.0.0.0      20.1.1.2     DR         broadcast 1
1      20.1.1.2      20.1.1.1     1500
Instance: vrfl
  Interface          Area          IP Address    State      Type      Cost
Priority DR          BDR          MTU
  memif-2/1/2/1     0.0.0.0      40.1.1.2     DR         broadcast 1
1      40.1.1.2      40.1.1.1     1500
supervisor@fwdd-r2: op> show ospf interface instance

```

3.1.3. OSPF Neighbor

Displays adjacency information.

Syntax:

show ospf neighbor <option>

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

Example: OSPF adjacency information for the default instance

```

supervisor@fwdd-r2: op> show ospf neighbor
Instance: default
  Address          Interface          Router ID Area          State      Priority DR
BDR              Uptime            Expires
  10.1.1.1         memif-0/1/2/1     1.1.1.1   0.0.0.0      Full       1
10.1.1.2         10.1.1.1          0d:05h:33m:40s 39 Seconds
  30.1.1.3         memif-0/2/3/1     5.5.5.5   0.0.0.0      Full       1
30.1.1.3         30.1.1.2          0d:05h:33m:40s 36 Seconds
  20.1.1.1         memif-1/1/2/1     1.1.1.1   0.0.0.0      Full       1
20.1.1.2         20.1.1.1          0d:05h:33m:40s 39 Seconds
Instance: vrfl
  Address          Interface          Router ID Area          State      Priority DR
BDR              Uptime            Expires
  40.1.1.1         memif-2/1/2/1     3.3.3.3   0.0.0.0      Full       1
40.1.1.2         40.1.1.1          0d:05h:33m:37s 40 Seconds
supervisor@fwdd-r2: op>

```

3.1.4. OSPF Database

Displays the entries in the OSPF link-state database, which contains data about link-state advertisement (LSA) packets.

Syntax:

show ospf database <option>

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

Example: OSPF database information for the default instance

```

supervisor@fwdd-r2: op> show ospf database
Instance: default, Area: 0.0.0.0
  Type          Link State ID  Adv Router    Age      Sequence Number  Checksum  Cost
  Router        1.1.1.1        1.1.1.1      1914    0x8000002e       7502
  Router        2.2.2.2        2.2.2.2      1442    0x800000cf       64388
  Router        5.5.5.5        5.5.5.5      883     0x800000b0       48439
  Network       10.1.1.2       2.2.2.2      2579    0x8000001e       8378
  Network       20.1.1.2       2.2.2.2      2579    0x80000020       39221
  Network       30.1.1.3       5.5.5.5      869     0x8000006c       53896
  Summary-Network 1.1.1.2       1.1.1.1      2766    0x8000001c       9682      1
  Opaque Area   4.0.0.0        2.2.2.2      399     0x80003069       56010
  Opaque Area   4.0.0.0        5.5.5.5      107     0x800001ca       21522
  Opaque Area   7.0.0.0        1.1.1.1      2034    0x8000001d       13222
Instance: vrfl, Area: 0.0.0.0
  Type          Link State ID  Adv Router    Age      Sequence Number  Checksum  Cost
  Router        3.3.3.3        3.3.3.3      1905    0x80000009       63459
  Router        4.4.4.4        4.4.4.4      6       0x80000022       34610
  Network       40.1.1.2       4.4.4.4      1554    0x8000001d       51739
Instance: default
  Type          Link State ID  Adv Router    Age      Sequence Number  Checksum  Cost
  External      4.1.2.4        2.2.2.2      1379    0x80000003       56353    0
supervisor@fwdd-r2: op>

```

3.1.4.1. OSPF Database for a Specific Area

Displays the LSAs in a particular area.

Syntax:

show ospf database area <area-id>

Option	Description
<area-id>	Area ID of the route.

Example: OSPF area identifier information for the default instance

```

supervisor@fwdd-r2: op> show ospf database area 0.0.0.0
Instance: default, Area: 0.0.0.0
  Type           Link State ID  Adv Router    Age      Sequence Number  Checksum  Cost
Router          1.1.1.1       1.1.1.1      1948    0x8000002e      7502
Router          2.2.2.2       2.2.2.2      1476    0x800000cf      64388
Router          5.5.5.5       5.5.5.5      917     0x800000b0      48439
Network         10.1.1.2      2.2.2.2      2613    0x8000001e      8378
Network         20.1.1.2      2.2.2.2      2613    0x80000020      39221
Network         30.1.1.3      5.5.5.5      903     0x8000006c      53896
Summary-Network 1.1.1.2       1.1.1.1      16      0x8000001d      9171      1
Opaque Area     4.0.0.0       2.2.2.2      433     0x80003069      56010
Opaque Area     4.0.0.0       5.5.5.5      112     0x800001cb      30952
Opaque Area     7.0.0.0       1.1.1.1      2068    0x8000001d      13222
Instance: vrf1, Area: 0.0.0.0
  Type           Link State ID  Adv Router    Age      Sequence Number  Checksum  Cost
Router          3.3.3.3       3.3.3.3      1939    0x80000009      63459
Router          4.4.4.4       4.4.4.4      40      0x80000022      34610
Network         40.1.1.2      4.4.4.4      1588    0x8000001d      51739
supervisor@fwdd-r2: op>

```

3.1.4.2. OSPF Database for External Routes

Displays external LSAs.

Syntax:

show ospf database external

Example: OSPF external route information for the default instance

```

supervisor@fwdd-r2: op> show ospf database external
Instance: default
  Type           Link State ID  Adv Router    Age      Sequence Number  Checksum  Cost
External        4.1.2.4       2.2.2.2      1441    0x80000003      56353    0
supervisor@fwdd-r2: op>

```

3.1.5. OSPF Route

Displays the entries in the OSPF routing table.

Syntax:

show ospf route <option>

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

Example: OSPF route information for the default instance


```

supervisor@fwdd-r2: op> show ospf route
Instance: default, SAFI: unicast
  Prefix          Area           Type           Cost           Next Hop
Interface
  1.1.1.2/32      0.0.0.0        inter-area     2              20.1.1.1
memif-1/1/2/1
                                     10.1.1.1
memif-0/1/2/1
  1.1.1.3/32      0.0.0.0        intra-area     2              20.1.1.1
memif-1/1/2/1
                                     10.1.1.1
memif-0/1/2/1
  10.1.1.0/24     0.0.0.0        Ospf_Direct   1              0.0.0.0
memif-0/1/2/1
  20.1.1.0/24     0.0.0.0        Ospf_Direct   1              0.0.0.0
memif-1/1/2/1
  30.1.1.0/24     0.0.0.0        Ospf_Direct   1              0.0.0.0
memif-0/2/3/1
Instance: vrfl, SAFI: unicast
  Prefix          Area           Type           Cost           Next Hop
Interface
  40.1.1.0/24     0.0.0.0        Ospf_Direct   1              0.0.0.0
memif-2/1/2/1
supervisor@fwdd-r2: op>

```

3.1.5.1. OSPF Labeled Unicast Routes

TBD

3.1.5.2. OSPF MPLS Routes

TBD

3.1.5.3. OSPF Unicast Route

Syntax:

show ospf route unicast

```

supervisor@fwdd-r2: op> show ospf route unicast
Instance: default, SAFI: unicast
  Prefix          Area          Type          Cost          Next Hop
Interface
  1.1.1.2/32      0.0.0.0       inter-area    2             20.1.1.1
memif-1/1/2/1
                                     10.1.1.1
memif-0/1/2/1
  1.1.1.3/32      0.0.0.0       intra-area    2             20.1.1.1
memif-1/1/2/1
                                     10.1.1.1
memif-0/1/2/1
  10.1.1.0/24     0.0.0.0       Ospf_Direct   1             0.0.0.0
memif-0/1/2/1
  20.1.1.0/24     0.0.0.0       Ospf_Direct   1             0.0.0.0
memif-1/1/2/1
  30.1.1.0/24     0.0.0.0       Ospf_Direct   1             0.0.0.0
memif-0/2/3/1
Instance: vrfl, SAFI: unicast
  Prefix          Area          Type          Cost          Next Hop
Interface
  40.1.1.0/24     0.0.0.0       Ospf_Direct   1             0.0.0.0
memif-2/1/2/1
supervisor@fwdd-r2: op>

```

3.1.6. OSPF SPF Result

Syntax:

show ospf spf result <option>

Option	Description
-	Without any option, the commands displays the information for all instances.
area <area-id>	Displays information about the specified area.
instance <instance-name>	OSPF summary information for the given instance.

Example: OSPF SPF Result for the default instance

```

supervisor@fwdd-r2: op> show ospf spf result
Instance: default, Area: 0.0.0.0
  Node ID      Type      Cost      Node Adv Router Flags      Neighbor Node
Interface      Nexthop
  1.1.1.1      ROUTER    1          1.1.1.1      1          1.1.1.1
memif-0/1/2/1  10.1.1.1
memif-1/1/2/1  20.1.1.1
  5.5.5.5      ROUTER    1          5.5.5.5      0          5.5.5.5
memif-0/2/3/1  30.1.1.3
Instance: vrf1, Area: 0.0.0.0
  Node ID      Type      Cost      Node Adv Router Flags      Neighbor Node
Interface      Nexthop
  3.3.3.3      ROUTER    1          3.3.3.3      0          3.3.3.3
memif-2/1/2/1  40.1.1.1
supervisor@fwdd-r2: op>

```

3.1.7. OSPF Statistics

3.1.7.1. OSPF Route Statistics

Displays OSPF statistics for all routing instances.

Syntax:

show ospf route statistics

Example: OSPF route statistics for all routing instances.

```

supervisor@fwdd-r2: op> show ospf route statistics
Instance: default
  Start Time      Elapsed Time      Reason      ID      Area
Intra  Inter  External
  2021-03-26 04:30:40  340us      SPF_CHANGE  1.1.1.1  0.0.0.0
1      1      0
  2021-03-26 04:30:40  31us       SPF_CHANGE  5.5.5.5  0.0.0.0
0      0      0
  2021-03-26 04:30:40  83us       SPF_CHANGE  30.1.1.3  0.0.0.0
1      0      0
  2021-03-26 04:30:46  308us      SPF_CHANGE  30.1.1.3  0.0.0.0
1      0      0
  2021-03-26 04:30:46  291us      SPF_CHANGE  1.1.1.1  0.0.0.0
1      1      0
  2021-03-26 04:30:46  22us       SPF_CHANGE  5.5.5.5  0.0.0.0
0      0      0
<....>

```

3.1.8. OSPF SPF Statistics

Displays OSPF SPF statistics for all routing instances.

Syntax:

show ospf spf statistics

```
supervisor@fwdd-r2: op> show ospf spf statistics
Instance: default
  Start Time           Elapsed Time      Area              Reason
  2021-03-26 04:30:02  1056us           0.0.0.0          R-LSA(01)
  2021-03-26 04:30:09  1059us           0.0.0.0          R-LSA(02)
  2021-03-26 04:30:40  1288us           0.0.0.0          R-LSA(06) N-LSA(01)
  2021-03-26 04:30:46  1164us           0.0.0.0          R-LSA(07) N-LSA(03)
  2021-03-26 04:30:48  1298us           0.0.0.0          R-LSA(08) N-LSA(04)
  2021-03-26 04:30:50  1513us           0.0.0.0          R-LSA(08) N-LSA(06)
  <....>
```

3.2. OSPF Clear Commands

3.2.1. Clear Neighbor Statistics

To clear neighbor statistics and reset adjacencies for OSPF, enter the following command:

Syntax:

clear ospf neighbor instance <instance> **area** <area-id> **interface**

Example:

```
supervisor@rtbrick: cfg> clear ospf neighbor instance default area 0.0.0.0 interface
```