



# Installation

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# 1. RBFS Installation, ZTP, and Licensing

## RBFS Installation Overview

The RBFS software is available for different roles based on their functions. RBFS C-BNG, Spine, Leaf and L2BSA images are stored in the RBFS image repository from where users can download and install the images on the supported hardware platforms. When new features and software patches become available in the image store, you can upgrade the software to use them. All the latest versions of software images are stored in the RBFS image store.

The RBFS software is delivered as custom RtBrick Linux container images (also called *RBFS container images*) which can be used for virtual topologies on x86 servers or as custom RtBrick ONL installer images that can be used on the supported white box switches.

*Image stores* containing the container and ONL installer images are published on <https://releases.rtbrick.com/> and updated when new image versions are available.

In addition to RBFS, other RtBrick software is delivered in the Debian package format that can be used on Ubuntu. Currently, the only supported Ubuntu release is 22.04 LTS Jammy. This category of software is referred to *RtBrick Tools*. The software delivered as Debian packages is composed of a set of CLI tools and/or daemons intended to facilitate working with RBFS containers and the RBFS API.

*Debian package repositories* containing the packages are available on <https://releases.rtbrick.com/> and updated whenever a new version of the package is available.

## Software Download

The RtBrick managed software download functionality enables authenticated users to download and install the RtBrick software (packages or images). Access to *image stores* and *Debian package repositories* on <https://releases.rtbrick.com/> is **restricted** through the use of TLS mutual authentication with TLS client certificates (TLS client certificates can be self-signed).

To access the **restricted** *image stores* and *Debian package repositories* on <https://releases.rtbrick.com/>, perform the following steps:

### Step 1: Generate a client certificate

RtBrick provides the `rtb-apt` tools to generate a client certificate. For more information, see the section [The RtBrick APT tool \(rtb-apt\)](#).

### Step 2: Send a client certificate to RtBrick

### Step 3: RtBrick approves and trusts the client's certificate

### Step 4: Download the RBFS software using the `rtb-apt`, `apt`, `rtb-image` tools



`rtb-image` version 1.3.0 or later is required to correctly work with managed downloads.

## The RtBrick APT tool (`rtb-apt`)

The `rtb-apt` tool is an APT (<https://wiki.debian.org/Apt>) utility application that provides an easier way for managing the system configuration of RtBrick package repositories (<https://wiki.debian.org/DebianRepository>)

which can be used with the usual `apt` commands to install RtBrick software.

Some RtBrick package repositories require authentication via TLS client certificates and the `rtb-apt` tool provides commands for managing those specific repositories and the required `apt` authentication configuration.

The `rtb-apt` tool is a statically compiled Linux 64-bit executable file. Currently, it is verified to run on **Ubuntu 22.04**. It is available through a direct download link.

## Install `rtb-apt`

Before you install `rtb-apt`, ensure that you have installed the following software:

- GNU Privacy Guard (GPG), which is used by `apt` to validate package repositories. To install GPG, enter the following command:

```
~ sudo apt install gnupg
```

- HTTPS support for **apt** is required to access the package repositories via HTTPS.

```
~ sudo apt install apt-transport-https ca-certificates
```

The following example shows how to download and install the **rtb-apt** tool. It shows the URL where the latest version of the **rtb-apt** tool is available for download:

```
~ curl -o /tmp/rtb-apt https://releases.rtbbrick.com/_/dl/sw/rtb-
apt/latest/linux_amd64/rtb-apt \
  && sudo mv /tmp/rtb-apt /usr/local/bin/ \
  && sudo chown root:root /usr/local/bin/rtb-apt \
  && sudo chmod 0755 /usr/local/bin/rtb-apt
```

The following example shows the **rtb-apt** tool version. The **rtb-apt** version 2.0.0 or later is required.

```
~ rtb-apt --version
2.0.0
```

## Generate a TLS client certificate

The following example shows how to generate a TLS client certificate using the **rtb-apt** tool.

```
~ sudo rtb-apt auth generate
A new self-signed TLS client certificate has been generated for this system:

Subject:      CN=bb59a25d-6b38-4f3c-81e0-065e525c8335,OU=rtb-apt
Valid until:  2024-09-06 10:30:26 +0000 UTC

The following additional auto-generated information is included in the certificate
and can be used to uniquely identify this system:

DNS names:    [hostname.example.net]
Email addresses: [root@hostname.example.net user@hostname.example.net]
< ..... >

If you already have a working account on https://portal.rtbbrick.com then you can
use the Self-Service section to upload this certificate. If you DO NOT yet have an
account on https://portal.rtbbrick.com, send the certificate to your RtBrick
support contact:
```

```
-----BEGIN CERTIFICATE-----
MIIHHzCCBYegAwIBAgIRAJcI5pqSK90+g6yJGB15i7YwDQYJKoZIhvcNAQELBQAw
QTEQMA4GA1UECzMHcnRiLWFwZDEtMCsGA1UEAxMkYmILOWEyNWQtNmIzOC00ZjNj
< ..... >
NuLIKfmwrcyXmzAOelbRtlJrRw0zofxX4rFcMmJREnqOV0obP5r7TCtnWtAqkFx/
7JJJa
-----END CERTIFICATE-----
```

After generating the TLS Client Certificate, upload it to the **Certificates** section on <https://portal.rtbrick.com>.

If your domain is registered with <https://portal.rtbrick.com>, you will be able to log into your account. If not, reach out to your sales/partner contact to initially have your domain registered with the portal.

## Identify and add RtBrick debian package repositories

### Find available repositories

The following example shows how to find the available repositories:

```
~ sudo rtb-apt repo list
Group          Repository      Distribution    Release Active Restricted
releases/latest rtbrick-tools  ubuntu         jammy   No       No
releases/23.8.1  rtbrick-tools  ubuntu         jammy   No       No
releases/23.9.1  rtbrick-tools  ubuntu         jammy   No       No
releases/23.10.1 rtbrick-tools  ubuntu         jammy   No       No
releases/23.11.1 rtbrick-tools  ubuntu         jammy   No       No
releases/23.12.1 rtbrick-tools  ubuntu         jammy   No       No
< ..... >

~ sudo rtb-apt repo show releases/latest/rtbrick-tools
Group          releases/latest
Description Packages repositories in the releases/latest group are updated with
new package versions for every final or
bugfix release.

Repository      rtbrick-tools
Description Packages for any RtBrick software not part of RBFS and meant
to run on an standalone Linux system (usually
Ubuntu). A standalone Linux system will be any non-RBFS
container and non-ONL Linux system. These packages can
be tools like rtb-image or rtb-ansible but also software like
ctrld or apigwd.
Distribution    ubuntu
Release        jammy
Active         No
Restricted     No
```

## Activate a repository

The following example shows how to activate a specific repository. `rtb-apt` will add the required configuration in `/etc/apt/` such so that the repository can then be used with commands such as `apt update` and `apt install`:

```
~ sudo rtb-apt repo activate releases/latest/rtbrick-tools
```

The activated repository is added to `/etc/apt/sources.list.d/rtbrick.list`:

```
~ cat /etc/apt/sources.list.d/rtbrick.list
deb [arch=amd64 signed-by=/etc/rtbrick/RtBrick-Support.pubkey.asc]
https://releases.rtbrick.com/_/latest/ubuntu/jammy/rtbrick-tools jammy
rtbrick-tools
```

## Verify active repositories

You can verify the active repositories using the command:

```
~ sudo rtb-apt repo list
Group          Repository      Distribution    Release Active Restricted
releases/latest rtbrick-tools  ubuntu         jammy  Yes   Yes  <<<<<<<<<
releases/23.8.1  rtbrick-tools  ubuntu         jammy  No    No
releases/23.9.1  rtbrick-tools  ubuntu         jammy  No    No
< ..... >
```

## Verify access (authentication) for the active package repositories

Some of the RtBrick package repositories are *restricted* meaning that they require the client application (`apt` in this case) to authenticate with a TLS client certificate. The TLS client certificate for the current system must be trusted by RtBrick. This is achieved either by uploading it in the Self-Service section of <https://portal.rtbrick.com> (if you already have a valid account on <https://portal.rtbrick.com>) or by sending your certificate to your RtBrick support contact.

### Expected output BEFORE the TLS client certificate is trusted by RtBrick

```
~ sudo rtb-apt auth check
Repository: releases/latest/rtbrick-tools ... restricted ... TLS client
```

```
certificate NOT accepted
```

## Expected output AFTER the TLS client certificate is trusted by RtBrick

```
~ sudo rtb-apt auth check
Repository: releases/latest/rtbrick-tools ... restricted ... TLS client
certificate accepted
```

## Install a package from an RtBrick package repository

Once the TLS client certificate for the current system is trusted by RtBrick and once RtBrick package repositories have been activated with `rtb-apt`, the `apt` commands can be used to install the RtBrick software contained in those package repositories.

The following example shows the installation of the `rtbrick-imgstore` package which provides the `rtb-image` CLI tool.

```
~ sudo apt update
Hit:1 https://releases.rtbbrick.com/_/latest/ubuntu/jammy/rtbrick-tools jammy
InRelease
Hit:3 http://archive.ubuntu.com/ubuntu jammy InRelease
Get:4 http://archive.ubuntu.com/ubuntu jammy-updates InRelease [119 kB]
Get:7 http://archive.ubuntu.com/ubuntu jammy-backports InRelease [109 kB]
Get:8 http://archive.ubuntu.com/ubuntu jammy-security InRelease [110 kB]
Get:9 http://archive.ubuntu.com/ubuntu jammy-updates/main amd64 Packages [970 kB]
Get:10 http://archive.ubuntu.com/ubuntu jammy-updates/universe amd64 Packages [979
kB]
< ..... >

~ sudo apt install rtbrick-imgstore
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
The following NEW packages will be installed:
  rtbrick-imgstore
0 upgraded, 1 newly installed, 0 to remove and 46 not upgraded.
Need to get 7,731 kB of archives.
After this operation, 26.3 MB of additional disk space will be used.
Get:1 https://releases.rtbbrick.com/_/latest/ubuntu/jammy/rtbrick-tools
jammy/rtbrick-tools amd64 rtbrick-imgstore amd64 3.3.0 [7,731 kB]
Fetched 7,731 kB in 0s (41.4 MB/s)
Selecting previously unselected package rtbrick-imgstore.
< ..... >
```

## Verify access (authentication) for image stores

The `rtb-image` command (CLI tool) provided by the `rtbrick-imgstore` package is



used to interact with *image stores*. The *image stores* are used for delivery of RBFS container images and RtBrick ONL installer images.

Similarly to package repositories some of the image stores are *restricted* meaning that they require the client application (`rtb-image` in this case) to authenticate with a TLS client certificate. `rtb-image` re-uses the TLS client certificate already generated by `rtb-apt` for the current system.

## View available image stores

The following example shows how to view the existing image stores:

```
~ sudo rtb-image stores list
```

Index	UUID	Name	RemoteURL
Active	Restricted		
0	af73c0a6-40e7-4775-b74b-aadafeabe86d	latest	
		https://releases.rtbrick.com/_/images/latest	Yes No
1	c4c896b0-52c5-4343-8a21-e2ca3ea440f1	resources	
		https://releases.rtbrick.com/_/resources	No No
2		22.5.1	
		https://releases.rtbrick.com/_/images/22.5.1	No No
3		22.6.1	
		https://releases.rtbrick.com/_/images/22.6.1	No No
4		22.7.1	
		https://releases.rtbrick.com/_/images/22.7.1	No No
< ..... >			

## Activate a restricted image store

The following example shows how to activate a (possibly restricted) image store:

```
~ sudo rtb-image stores activate 0
```

## Verify access to image stores

If the TLS client certificate for the current system is already trusted by RtBrick, you can use `rtb-image` to download the images.

The following example shows how to verify the access to the image stores:

```
~ sudo rtb-image auth check
Image store: latest (af73c0a6-40e7-4775-b74b-aadafeabe86d) ... restricted ... TLS
client certificate accepted
```

The following example shows how to download an RBFS container image for the *virtual* platform and how to run a test container with it:

```

~ sudo rtb-image update
Local image store cached copy updated to: Store:
/var/cache/rtbrick/imagestores/af73c0a6-40e7-4775-b74b-aadafeabe86d Version:
0.9.102 ValidUntil: 2023-09-23 07:03:28

~ sudo rtb-image list -p virtual -r spine -v latest

Store: /var/cache/rtbrick/imagestores/af73c0a6-40e7-4775-b74b-aadafeabe86d
Version: 0.9.102 ValidUntil: 2023-09-23 07:03:28

UUID                               Version Filename
Format Role Platform Cached
af7108e0-95b3-4e25-91a4-a2cee7a63a38 23.6.1 rbfs-cont/rbfs-spine-virtual-
23.6.0-g8daily.202306210... lxd spine virtual false

~ sudo rtb-image pull af7108e0-95b3-4e25-91a4-a2cee7a63a38
rbfs-spine-virtual-23.6.0-g8daily.20230621060657+Bmaster.Cf5ebfbd4.tar.zst.sha512
225 B / 225 B [=====] 100.00%
0s
rbfs-spine-virtual-23.6.0-g8daily.20230621060657+Bmaster.Cf5ebfbd4.tar.zst.asc 833
B / 833 B [=====] 100.00%
0s
rbfs-spine-virtual-23.6.0-g8daily.20230621060657+Bmaster.Cf5ebfbd4.tar.zst 435.06
MiB / 435.06 MiB [=====] 100.00%
4s
rbfs-spine-virtual-23.6.0-g8daily.20230621060657+Bmaster.Cf5ebfbd4.tar.zst:
decompressing 100 B / 100 B [=====]
100.00% 10s
af7108e0-95b3-4e25-91a4-a2cee7a63a38 downloaded as
/var/cache/rtbrick/imagestores/af73c0a6-40e7-4775-b74b-aadafeabe86d/rbfs-
cont/rbfs-spine-virtual-23.6.0-g8daily.20230621060657+Bmaster.Cf5ebfbd4

~ sudo rtb-image run -n testRBFScont01 af7108e0-95b3-4e25-91a4-a2cee7a63a38
2023-09-08 15:15:11 UTC INF creating container testRBFScont01 with image version:
23.6.1 image uuid: af7108e0-95b3-4e25-91a4-a2cee7a63a38
2023-09-08 15:15:11 UTC INF Trying to start container container=testRBFScont01
2023-09-08 15:15:11 UTC INF Waiting for container IP addresses
container=testRBFScont01
2023-09-08 15:15:15 UTC INF Updating /etc/hosts entry address=10.0.3.96
container=testRBFScont01
2023-09-08 15:15:15 UTC INF Container was started container=testRBFScont01

~ rssh testRBFScont01
Logging into testRBFScont01 as supervisor ...

+-----+
|
| RBFS container testRBFScont01 running on ubuntu2204host:
|   Date:      Fri Sep  8 15:15:23 UTC 2023
|   Uptime:    up
|
| Image metadata:
|   UUID:     af7108e0-95b3-4e25-91a4-a2cee7a63a38
|   Version:  23.6.1
|   Role:     spine
|   Platform: virtual
|
+-----+

```

```
Format:      lxd
Build date:  2023-06-21 06:06:57 UTC
Based on:    Ubuntu 18.04.6 LTS
```

```
|-----|
+-----+
```

```
supervisor@testRBFScnt01>ubuntu2204host:~ $
```

## Understanding RBFS Release Versioning

An RBFS release can be defined as a set of software packages (currently, in the Debian package format). However, it is delivered as an image, either a container (LXC/LXD) image or as a complete ONL installation image. The ONL installation image may or may not contain a container image pre-installed in it. An image can be defined as the archived root file system of a Linux OS installation with the needed software packages pre-installed and with a default configuration. In the current context, the terms 'RBFS release' and 'image' are used interchangeably.

RtBrick uses a versioning scheme called `rtbver` for RBFS release versioning. An `rtbver` version string is syntactically similar to SEMVER 2.0, but semantically different. For the RBFS releases, the first two numbers of a version is YEAR.MONTH (corresponding to the MAJOR.MINOR of SEMVER). For example, the first RBFS release in a calendar month is 22.4.1. If a second RBFS release occurs in the same calendar month gets version as 22.4.2. The RBFS release in the next calendar month will have a version (for example) 22.5.1 irrespective of how many RBFS releases occurred in the previous calendar month.

The `rtbver` scheme also supports four-number versioning, such as 22.4.1.1. This four-number version is used for maintenance releases. Maintenance releases are built only when required, based on and for an already existing RBFS release (such as 22.4.1.1 for 22.4.1.).

## RtBrick Tools Installation

The installation of RtBrick tools is split into several steps, as follows:



The following commands and outputs are validated only on Ubuntu 22.04.

## Step 1: Removing any existing RtBrick tools Debian packages

Some of the RtBrick tools Debian packages have changed and have been upgraded several times. If any of the RtBrick tools packages are already installed, it is essential to remove any existing package.

```
apt list --installed | egrep -i rtbrick | awk -F '/' '{print $1;}' | xargs sudo apt remove -y
```

In the output, you can see the following:

The following packages are removed.

```
rtbrick-ansible rtbrick-imgstore rtbrick-lxc-tools
```

## Step 2: Use `rtb-apt` to configure debian package repositories

## Step 3: Update the local apt package cache

Update the local apt package cache using the command: `sudo apt update`

## Step 5: Install third-party dependencies

Some RtBrick tools or packages have dependencies on third-party software such as Ansible. These third-party software packages are not delivered through the RtBrick package repositories.

Currently, the `rtbrick-ansible` package depends on Ansible software. For information about installing Ansible, see [https://docs.ansible.com/ansible/latest/installation\\_guide/intro\\_installation.html#installing-ansible-on-ubuntu](https://docs.ansible.com/ansible/latest/installation_guide/intro_installation.html#installing-ansible-on-ubuntu).



You can install and run the `rtbrick-ansible` package only after installing Ansible. Ensure that you have installed the latest version of Ansible, before installing `rtbrick-ansible`.

## Step 6: Install a specific RtBrick tool package

Install a particular RtBrick tool package, run the command:

```
sudo apt install <tool name>
```

For example, to install the `rtbrick-ansible` package, run the following command:

```
sudo apt install rtbrick-ansible
```

## Image formats and ONL image installation for supported hardware

RtBrick images delivered through the RtBrick image store and the `rtb-image` utility have three main attributes:

- **format**: This is the file format in which the image is packaged and archived.
- **role**: The role inside a network of the device which will be running the image.
- **platform**: Identifies the hardware platform or virtualized environment in which the image can run.

RtBrick images intended to be used as containers in a virtualized environment contains `format == lxd` and `platform == virtual`.

RtBrick images intended to be installed on supported hardware devices contain `format == onl-installer` and `platform` set accordingly to the specific switching hardware.



You can see this using `rtb-image list` command and looking for the `Format` column.

## ONL images

ONL images are generally installed using the Zero-Touch Provisioning (ZTP) process. The [\[Installation\]](#) section applies for both virtual and hardware installations, with the difference that, when having a physical deployment (One with a ZTP server and switched running ONL images) we can install just the `rtbrick-imgstore` package on the ZTP server, since it doesn't have Ansible as dependency (Ansible not being a part of the default Ubuntu repositories), and because generally you will not have containers running on the ZTP server itself.

A typical ONL image downloaded looks as in the following snippet:

```
rtbrick@access-test:~$ sudo rtb-image update
Local image store cached copy updated to: Store:
/var/cache/rtbrick/imagestores/847c6ecd-df58-462e-a447-38c620a12fe1 Version:
```

```

0.22.6360 ValidUntil: 2195-05-21 12:27:50.527696657 +0000 UTC

rtbrick@access-test:~$ sudo rtb-image list --format onl-installer --platform qmx
--role spine --ver-range latest

Store: /var/cache/rtbrick/imagestores/847c6ecd-df58-462e-a447-38c620a12fel
Version: 0.22.6360 ValidUntil: 2195-05-21 12:27:50.527696657 +0000 UTC

UUID                               Version
Filename                           Format           Role           Platform
Cached
fa52399e-a2d8-48f0-8ad0-5b17b69b826d  22.6.0-
g8daily.20220605220700+Bmaster.C2f0...  rtbrick-onl-installer/rtbrick-onl-
installe...  onl-installer  spine  qmx          false

rtbrick@access-test:~$ sudo rtb-image pull fa52399e-a2d8-48f0-8ad0-5b17b69b826d
rtbrick-onl-installer-spine-qmx-22.6.0-
g8daily.20220605220700+Bmaster.C2f0eae65.d.sha512 244 B / 244 B
[=====] 100.00% 0s
rtbrick-onl-installer-spine-qmx-22.6.0-
g8daily.20220605220700+Bmaster.C2f0eae65.d.asc 833 B / 833 B
[=====] 100.00%
0s
rtbrick-onl-installer-spine-qmx-22.6.0-g8daily.20220605220700+Bmaster.C2f0eae65.d
1.15 GiB / 1.15 GiB
[=====] 100.00% 5s
rtbrick-onl-installer-spine-qmx-22.6.0-g8daily.20220605220700+Bmaster.C2f0eae65.d:
decompressing 100 B / 100 B
[=====] 100.00% 0s

rtbrick@access-test:~$ sudo rtb-image show fa52399e-a2d8-48f0-8ad0-5b17b69b826d

Store: /var/cache/rtbrick/imagestores/847c6ecd-df58-462e-a447-38c620a12fel
Version: 0.22.6360 ValidUntil: 2195-05-21 12:27:50.527696657 +0000 UTC

UUID:                fa52399e-a2d8-48f0-8ad0-5b17b69b826d
Version:             22.6.0-g8daily.20220605220700+Bmaster.C2f0eae65
Creation Date:      2022-06-06 03:37:00 +0530 IST (7 hours ago)
Role:               spine
Platform:           qmx
Format:             onl-installer
Architecture:      amd64
Filename:           rtbrick-onl-installer/rtbrick-onl-installer-spine-qmx-22.6.0-
g8daily.20220605220700+Bmaster.C2f0eae65.d
FullPath/URL:       /var/cache/rtbrick/imagestores/847c6ecd-df58-462e-a447-
38c620a12fel/rtbrick-onl-installer/rtbrick-onl-installer-spine-qmx-22.6.0-
g8daily.20220605220700+Bmaster.C2f0eae65.d
SHA512:
9a6b989edacf8daedc656dce310eb4ad680dc3cd5afd16a9c1783bb57ac78c97b4cc2d30fd0ac91edd
2ef7a86c7d6aea6441ef2ef0fbd16cd1f682f21601ed64
Base Image:         fd52536e-bd16-421d-a883-da263768aeb6
Embedded Packages: 18
Embedded Images:   1
Cached:             true
ExtractedPath:

```

In a design where the download of the image happens on a different server than the ZTP used for the actual installation, you can install the *rtbrick-imgstore* package,

---

and move by some means ( `rsync`, for example) the images from `var/cache/rtbrick/imagestore/` of that internet-connected to the ZTP server.

## The `rtb-ssh` command

The `rtb-ssh` command allows you to connect to a container that is already running.

The command was previously called `rssh`, and it was renamed as it confused with Linux's restricted shell `rssh` package which is available in the official Ubuntu `apt` package repositories.

Besides renaming, a few changes have been made to the `rtb-ssh` / `rssh` script.

The script is installed automatically as part of the `rtbrick-imgstore` package installation.

The script uses `lxc-attach` to establish a connection to the container specified as the argument. While doing so, it uses the `ubuntu` user (currently, the default user inside an RBFS container) to connect to the container, and uses the `bash` shell after opening the connection.

Before connecting, it clears the environment before attaching, so no undesired environment variables leak into the container. The variable `container=lxc` is the only environment with which the attached program starts.

It only keeps the `TERM` variable, to have the same strings the user is currently using for clear screen, move cursor, and so on.

The `rtb-ssh` is installed in the `/usr/local/bin/` path (alongside `rtb-image`, etc.). For convenience and backward compatibility the script is still also installed as `rssh`.

## Installing ONL Manually

You can install open network Linux (ONL) manually on a bare-metal switch. Open Network Install Environment (ONIE) should be installed on the switch. The Open Network Install Environment (ONIE) is an open-source utility that provides an installation environment for bare-metal switches. ONIE is used to install different network operating systems (NOS) on a device.

The RtBrick ONL installer images are compatible with ONIE and can be used by ONIE to install an RtBrick ONL (Open Network Linux) on a bare-metal switch.



- When installing ONL, any existing configurations on the switch will be deleted.
- The current RBFS configurations can be retrieved via a REST call from the RESTCONF endpoint. If you have saved the RBFS configuration using this method, you can load it onto the switch through a RESTCONF endpoint. For more information, refer to the following sections of the RtBrick documentation.

[Using the Proxy Endpoint](#)

[RESTCONF API: Use Cases and Examples](#)

## Prerequisites

- Ensure that ONIE has been installed on the switch by the vendor of the switch. If ONIE is not unavailable with the switch, contact the switch vendor.
- Ensure that the switch management interface has been provisioned with an IP address either through manual configuration or through DHCP.
- Ensure that you have set up the necessary infrastructure to download RtBrick ONL installer images on your environment. For information, see section *RtBrick Tools Installation*.
- Ensure that you have set up an HTTP server that will make available the downloaded images for ONIE to use. For more information, see <https://opencomputeproject.github.io/onie/user-guide/index.html#installing-over-the-network>

## Installation Procedure

To install the ONL image, perform the following steps:



On a fresh box, ONL prompt is not available, so skip to ONIE prompt section.

### ONL prompt section:

#### Option 1: Manually select ONIE boot mode

1. Connect to the console port
2. Reboot the device



```
root@b11-pod1:~# reboot
```

3. Once the selection menu appears as shown in the selection menu below, select "**ONIE**" and press enter.

```

GNU GRUB version 2.02
+-----+
| Open Network Linux
| *ONIE <----- Select this one
+-----+

Use the ^ and v keys to select which entry is highlighted.
Press enter to boot the selected OS, `e' to edit the commands
before booting or `c' for a command-line.
```

4. Select "**ONIE: Install OS**" from the next selection menu displayed.

```

GNU GRUB version 2.02
+-----+
| *ONIE: Install OS <----- Select this one
| ONIE: Rescue
| ONIE: Uninstall OS
| ONIE: Update ONIE
| ONIE: Embed ONIE
+-----+

Use the ^ and v keys to select which entry is highlighted.
Press enter to boot the selected OS, `e' to edit the commands
before booting or `c' for a command-line.
```

5. Wait for the "**ONIE:/ #**" prompt.

```
NOTICE: ONIE started in NOS install mode. Install mode persists
NOTICE: until a NOS installer runs successfully.
```

```
** Installer Mode Enabled **
ONIE:/ #
ONIE:/ #
ONIE:/ #
```

Provide the URL of the ONL installer image location.

```
ONIE:/ # onie-nos-install http://server.example.net/_/images/latest/rtbrick-onl-
ins
taller/rtbrick-onl-installer-spine-q2c-21.9.1.d
```

Wait until the device displays the "**login:**" prompt after the image upgrade

completes. You can then log into the device and verify the image version.

## Option 2: Preselect ONIE boot mode

1. Connect to the console port
2. Select ONIE boot mode

```

root@onl>b11-pod1:~ # onl-onie-boot-mode --help
usage: onl-onie-boot-mode [-h] [--onie-only]
                        {install,rescue,uninstall,update,embed,diag,none}

positional arguments:
  {install,rescue,uninstall,update,embed,diag,none}

optional arguments:
  -h, --help            show this help message and exit
  --onie-only           Do not set ONIE boot menu option.
root@onl>b11-pod1:~ #

root@onl>b11-pod1:~ # onl-onie-boot-mode install
The system will boot into ONIE install mode at the next restart.
root@onl>b11-pod1:~ #

```

### 3. Reboot switch

```

root@onl>b11-pod1:~ # reboot

```

## ONIE prompt section:

You must update the URL of the ONL installer image location as per your specific HTTP server configuration.

```

ONIE:/ # onie-discovery-stop
NOTICE: The 'onie-discovery-stop' command is deprecated and will be removed in
2019.02.
NOTICE: Use 'onie-stop' instead.
discover: installer mode detected.
Stopping: discover... done.

ONIE:/ # onie-nos-install http://server.example.net/_/images/latest/rtbrick-onl-
ins
taller/rtbrick-onl-installer-spine-q2c-21.9.1.d

discover: installer mode detected.
Stopping: discover... done.

Info: Attempting http://server.example.net/_/images/latest/rtbrick-onl-
installer/rtbrick-onl-installer-spine-q2c-21.9.1.d ...

Connecting to server.example.net (198.51.100.125)
installer 100% |*****| 1176M 0:00:00 ETA

```

```
ONIE: Executing installer: http://server.example.net/_/images/latest/rtbrick-onl-  
installer/rtbrick-onl-installer-spine-q2c-21.9.1.d
```

## 2. Zero Touch Provisioning

### Overview

Zero Touch Provisioning (ZTP) automates the tasks of installing software images. It is a method for setting up and configuring devices automatically. ZTP installs or upgrades the RBFS software image on your hardware platforms without any manual intervention.

ZTP automatically provisions routers newly installed in the network and it is very useful in deploying routers in a large-scale environment as it eliminates much of the manual intervention. ZTP is also used to automate the software upgrade process and help with a high level of network automation.

### ZTP Workflow

A new hardware platform comes pre-installed with the ONIE (Open Network Installation Environment). ONIE is an open-source installation environment that acts as an enhanced boot loader utilizing capabilities in a Linux or BusyBox environment. ONIE allows users and channel partners to install the Network Operating System as part of provisioning.

ONIE requires a management LAN to obtain the configuration and software image information through the management interface. ONIE can access only the management interface. It starts a Dynamic Host Configuration Protocol (DHCP) based discovery process to obtain basic configuration information, such as the management IP address and the URL of the image to install on the bare-metal switch.

Then ONIE pulls the image and boots it.

Even after ONIE boots the image, the switch is not configured. This leads to questions about how to configure the switch.

The RtBrick images come with some pre-installed daemons. The pre-installed Control Daemon (CtrlD) is responsible for the management of the switch, and takes over after the image is activated.

The Control Daemon is responsible for configuring the switch. To do this, the

hardware platform must be connected to the DHCP server and the management server through a management LAN.

The management server is responsible for providing the image binaries and the configuration of each device.

In the ZTP, ONIE performs the role of discovering, downloading and activating the image from the image registry.

In essence, the following is the high-level workflow of ZTP process:

**ONIE performs the following tasks:**

- DHCP discovery
- Image download
- Image activation

**Control Daemon performs the following tasks:**

- DHCP discovery
- Switch configuration

ONIE allows to automate the firmware update. The image request to the management server is slightly different, and the management server needs to provide the firmware update image that the device vendor provides.

This section provides information about the NOS installation and firmware (FW) update.

## **ZTP Process**

This section provides information about ZTP process. Figure. 1 illustrates the ZTP process at a high level.

The ZTP process is divided into two main parts:

### **Software Image Discovery and Installation**

The ONIE in the device uses information that you have defined on the Dynamic Host Configuration Protocol (DHCP) server to locate the IP address and image download URL.

- ONIE uses different ways to pull the image from the repository for downloading. In the ZTP process, HTTP is used to pull the image because ONIE conveys the serial number as the HTTP header. This serial number allows the image registry to identify the switch and select the appropriate image.

Along with the serial number, ONIE also sends the **onie-operation** that allows to distinguish between an **os-install** and **onie-update**, and select the correct image for either NOS install or firmware upgrade.

- See the ONIE image discovery for further information (/ONIE/)
- CtrlID configuration discovery and application.
- CtrlID sends DHCPINFORM to request all options required for configuration discovery.
- The configurations are downloaded from the management server (**httpd**) and applied.

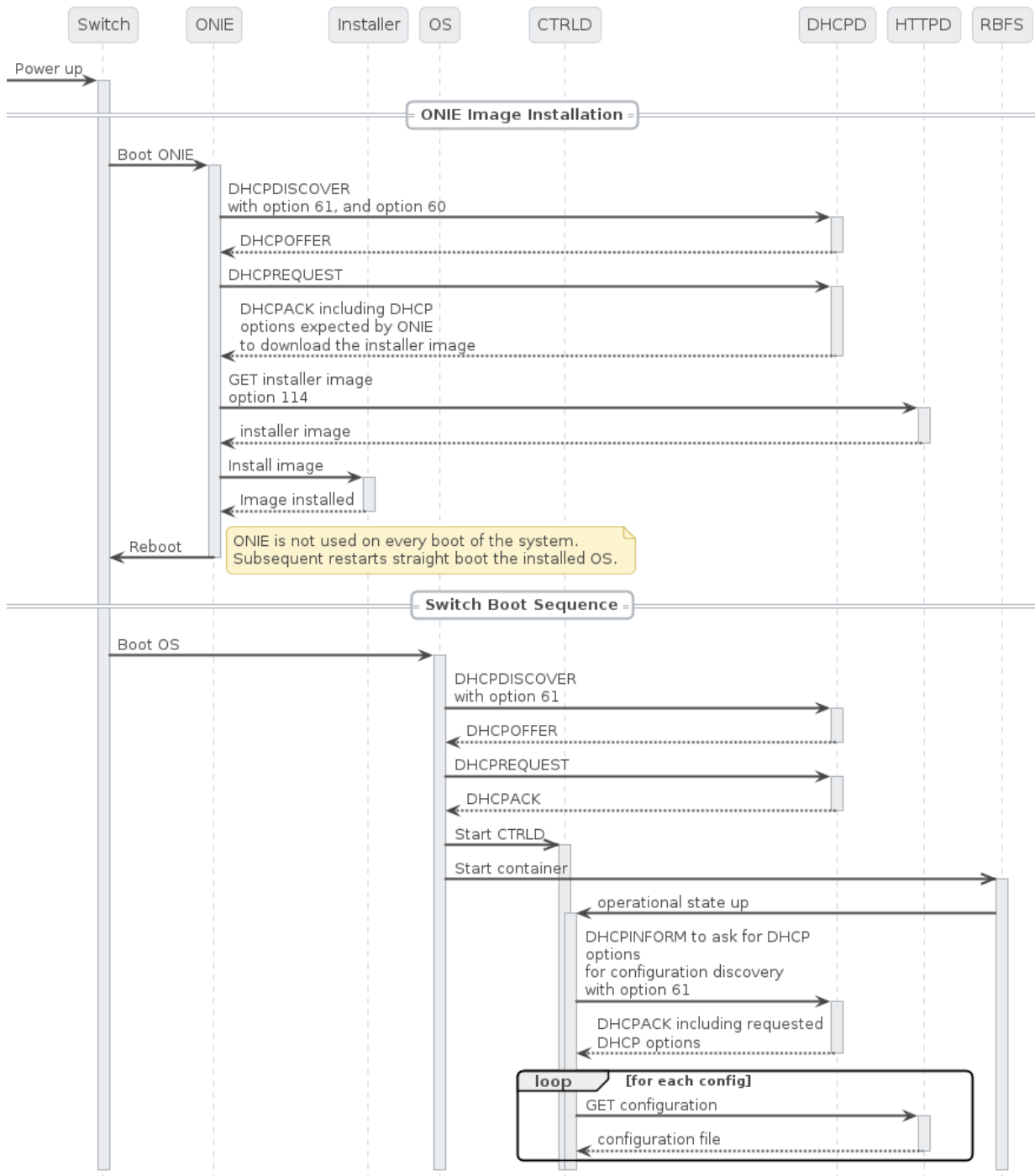


Figure 1. The ZTP Process

Figure 2. depicts the relationship between the fabric, the DHCP server, and the management server.

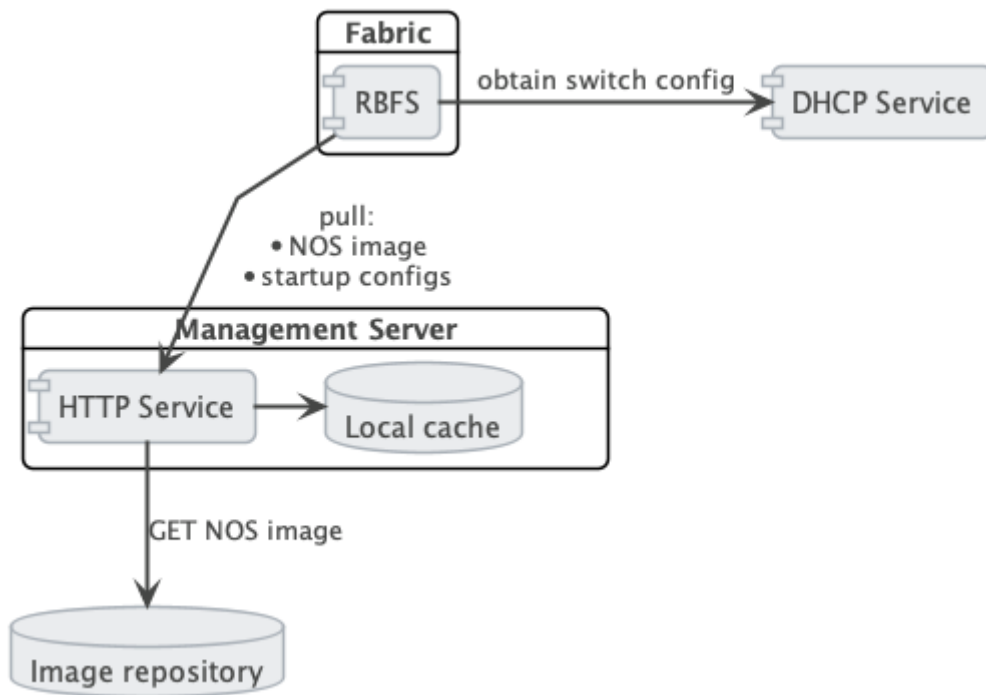


Figure 2. The Management Server Architecture

## DHCP Service

Because of its low set of requirements, the default DHCP server shipped with ubuntu, `isc-dhcp`, is used to run the DHCP service.

The following code shows an example configuration of a DHCP server and hardware box (**`dhcp.conf`**).

*dhcp.conf*

```
authoritative;
default-lease-time 600;
max-lease-time 72----

# This is only needed if the version is lower than 4.4
option loader-pathprefix code 210 = text;

subnet 10.0.0.0 netmask 255.255.255.0 {
    range 10.0.0.200 10.0.0.250;
    option routers 10.0.0.138;
    option domain-name-servers 10.0.0.210;
    option domain-name "local";
    host LEAF01 {
        # Identify client by MAC address.
        hardware ethernet 48:65:ee:11:da:85;
        # Identify client by serial number
        option dhcp-client-identifier "\000WLC1C27L00003P2";
        fixed-address 10.0.0.250;
        option host-name LEAF01;
    }
}
```



```
# Set DHCP option 114 (default-url) to set the installer image URL.
# ONIE loads the installer image from the specified URL.
option default-url "http://managementserver/ztp/image";
# Set DHCP option 210 (path prefix) to set the configuration base URL.
# CTRLD loads all configuration files from this base URL.
option loader-pathprefix "http://managementserver";
}
}
```

Most of the used options are already predefined in the ISC-DHCP server. You can see the reference under [/ISCKB/](#), the `loader-pathprefix` is defined since DHCP 4.4, so if you use an older one, define it as described above.

## HTTP Service (Management Server)

The HTTP daemon (`httpd`) is responsible for providing the NOS installer and the configuration files.

Therefore, a self-implemented Golang HTTP server is used, which reads the `ONIE_SERIAL_NUMBER` and `ONIE-OPERATION` HTTP header and maps them to the NOS/FW installer image download path, and maps the serial number to the ZTP configuration files. For more details about the configuration files, see the following section.

The `ONIE-OPERATION` header can have the following values:

- install nos: `os-install`
- update firmware: `onie-update`

The following sections provide information about the installation and configuration of the server.

## ZTP installation

For the installation, you can choose any one of the following two options:

### ZTP Installation with the Debian Package

You must perform the following steps for ZTP installation using the Debian package.

- Ensure that you have added the `rtrbick` repository to your `apt.sources` list and updated the cache.

- Ensure that the port **80** is available and not in use on your device.
- Install the package **rtbrick-fabric-ztp**.
- The package installs a **systemd** service named **rtbrick-fabric-ztp**.
- Ensure that the service is running with **sudo systemctl status rtbrick-fabric-ztp**.
- The default location for the ZTP configuration files is **/var/rtbrick/ztp/configs/** where you need to copy your configuration files.

If you want to override server settings, perform the following:

- Edit the service configuration file **/etc/systemd/system/rtbrick-fabric-ztp.service** and add parameters to the **ExecStart** command.
- Parameter **--addr**: the listen address of the server, default is **0.0.0.0:80**.
- Parameter **--requestTimeout**: the request timeout server in seconds, default is **600**, must possibly be increased depending on the connection speed and image file sizes.
- Parameter **--filePath**: the location for the ZTP configuration files, the default location is **/var/rtbrick/ztp/configs/**.

## ZTP Installation as Docker Container

You must perform the following steps for ZTP installation as a docker container.

- Ensure that you have access to the **rtbrick** docker registry.
- Ensure that the port **80** is available and not in use on your device.
- Create a compose file **docker-compose.yml**. The following is a sample compose file.

```
version: '3.3'
services:
  ztp:
    image: 'docker.rtbrick.com/rbms-fabric-ztp:latest'
    container_name: rbms-fabric-ztp
    restart: unless-stopped
    ports:
      - '80:80'
    volumes:
      - './configs:/var/rtbrick/ztp/configs'
```

- The compose setup uses a 'bind mound' method for the ZTP configuration

folder. Therefore, the `docker-compose.yml` must be placed in the same location together with the `.configs` folder for the ZTP configurations. To know the details of the configuration files, see the following sections.

- If required, adapt the compose file for a different image version, port binding or different configuration folder location.
- Start the container using the `docker-compose up -d` command.

## ZTP configuration

The HTTP service matches the `ONIE-SERIAL-NUMBER` header to the configuration files. Therefore, the configuration folder should contain a JSON file for the serial number (`<serial_number>.json`) for each supported serial number.

This file contains settings for locations of all additional configuration files that have to be delivered for the specific device and settings for the NOS installer image and the firmware update image.

Example `sample.json` file for a serial number 'sample':

`/var/rtbrick/ztp/configs/sample.json`

```
{
  "description": "192.168.202.116",
  "ctrlld": "ctrlld.json",
  "ctrlldrbac": "ctrlldrbac.json",
  "startup": "sample_startup.json",
  "accessjwks": "sample_accessjwks.json",
  "apigwd": "sample_apigwd.json",
  "tls": "sample_tls.pem",
  "image": "http://pkg.rtbrick.net/_/images/latest/rtbrick-onl-installer/rtbrick-onl-installer-accessleaf-qmx-20.4.0-g8daily.20200415051734+Bmaster.C059a09ea",
  "update_image": "http://pgk.rtbrick.net/firmwares/onie-firmware-x86_64-ufispace_s9600_32x_ufispace_s9600_64x-r0_v0.3.0.updater"
}
```

## Image Location Configuration

For the configuration entries `"image"` and `"update_image"` you have three possibilities:

- Redirect URL: Configuration value must start with `http`, the server redirects the request to download the image from the URL. For example, `"http://pkg.rtbrick.net/_/images/latest/rtbrick-onl-installer/rtbrick-onl-installer-accessleaf-qmx-20.4.0-g8daily.20200415051734+Bmaster.C059a09ea"`

- **Absolute File Location:** config value must start with `/`, can point to any file on the local disk, example `/usr/share/images/rtbrick-onl-installer.img`.
- **Relative File Location:** config value must be a filename and not start with `/`, points to any file in the `<ztpath>/configs/images/` folder, example "rtbrick-onl-installer.img"

## ZTP APIs

For information about ZTP REST APIs, refer to the </resources/techdocs/24.7.1/api/rbms-apis.html>[ZTP Management Server API].

## Control Daemon

Once the RBFS image is activated by ONIE, Control Daemon (CtrlD) is responsible for executing the remaining tasks and configuring the switch. CtrlD acts as a post-ZTP daemon, it runs after the image is activated.

There are various configuration files that CtrlD can load from a management server and apply to the system.

- **CtrlD config:** This is the base configuration for CtrlD. There the RBMS and Graylog can be specified, but also the authentication and authorization mechanism can be controlled.
- **CtrlD rbac policy:** The Role Based Access Control (RBAC) policy of CtrlD is defined in this configuration file.
- **Startup Config:** This is the file for RBFS switch configuration.
- **TLS pem file:** This file is intended for the API Gateway (ApiGwD). The file is an X509 public/private key file in PEM format defined in the [RFC7468](#).
- **Access JWKS file:** This file is intended for the ApiGwD. The JSON Web Key Set (JKWS) is described in the [RFC 7517](#).

## Trigger the ZTP process

The ZTP process in CtrlD is triggered for a specific container (LXC) on the switch. This can be triggered in the following ways.

- By the switch (RBFS Linux container) itself by sending the *operational state up* to CtrlD.

- By sending a REST request to trigger the ZTP process to CtrlID (/api/v1/ctrlid/ztp/\_run).

If 'load-last-config' option is set to true, ZTP is in the disabled state. ZTP is enabled if load-last-config is false.

By default, 'load-last-config' is false and ZTP is enabled. You must set to 'load-last-config' true to disable ZTP.

## Trigger the reinstall

The reinstall of a switch can be triggered by sending a POST request to CtrlID (/api/v1/ctrlid/system/\_reinstall)

## Trigger Firmware Update

The firmware update of a switch can be triggered by sending a POST request to CtrlID (/api/v1/ctrlid/system/\_update)

## Management Server URL Discovery

CtrlID has to discover the management server URL to download the configuration files from the management server. Therefore, a management interface, that allows sending an DHCPINFORM request to the DHCP server, is defined.

The request contains **DHCP option 60**, that conveys the vendor class identifier "rtbrick", which informs the DHCP server about the vendor information.

The request contains the **DHCP option 61** that conveys the client identifier. The client identifier is either omitted or contains the serial number. The serial number is gathered from the ONIE file system information file [/lib/platform-config/current/onl/onie-info.json](#). If that does not result in a valuable result the following command is executed `dmidecode -s system-serial-number` (see [/RFC2131/](#) and [/RFC2132/](#) for further information).

There are at least two DHCP options requested, **DHCP option 54** that conveys the IP address of the DHCP server (see [/RFC2132/](#) for further information), and **DHCP option 210** that conveys the path prefix for all configuration files (see [/RFC5071/](#) for further information).

If the DHCP option 210 is not returned, CtrlID attempts to read the configurations

from the IP address of the ZTP server. Otherwise, CtrlID attempts to read the configurations from the base URL specified in DHCP option 210.

## Request configurations

The request to the Management server contains the following HTTP headers:

- ONIE-SERIAL-NUMBER: This serial number is either the onie serial number or empty string.
- CONTAINER-NAME: Container that triggered the ZTP process.
- ELEMENT-NAME: Element name that triggered the ZTP process.
- HOST-NAME: Host name of the device that triggered the ZTP process.



All this information can be used to select the right configurations for the container. This also allows the use of ZTP Configuration Process for virtual environments.

The requested URL:

- CtrlID Config: <management server url>/ztp/config/ctrlid
- CtrlID rbac policy: <management server url>/ztp/config/ctrlidrbac
- Startup Config: <management server url>/ztp/config/startup
- TLS pem file: <management server url>/ztp/config/tls
- Access JWKS file: <management server url>/ztp/config/accessjwks

If any of the file is not found, the process still goes forward.

## Business Events

During the ZTP Process log messages are sent to the configured **ztp** graylog endpoint.

For more information, see the switch API documentation.

## Overall Process Flow

The following two figures show the CtrlID ZTP process flow.

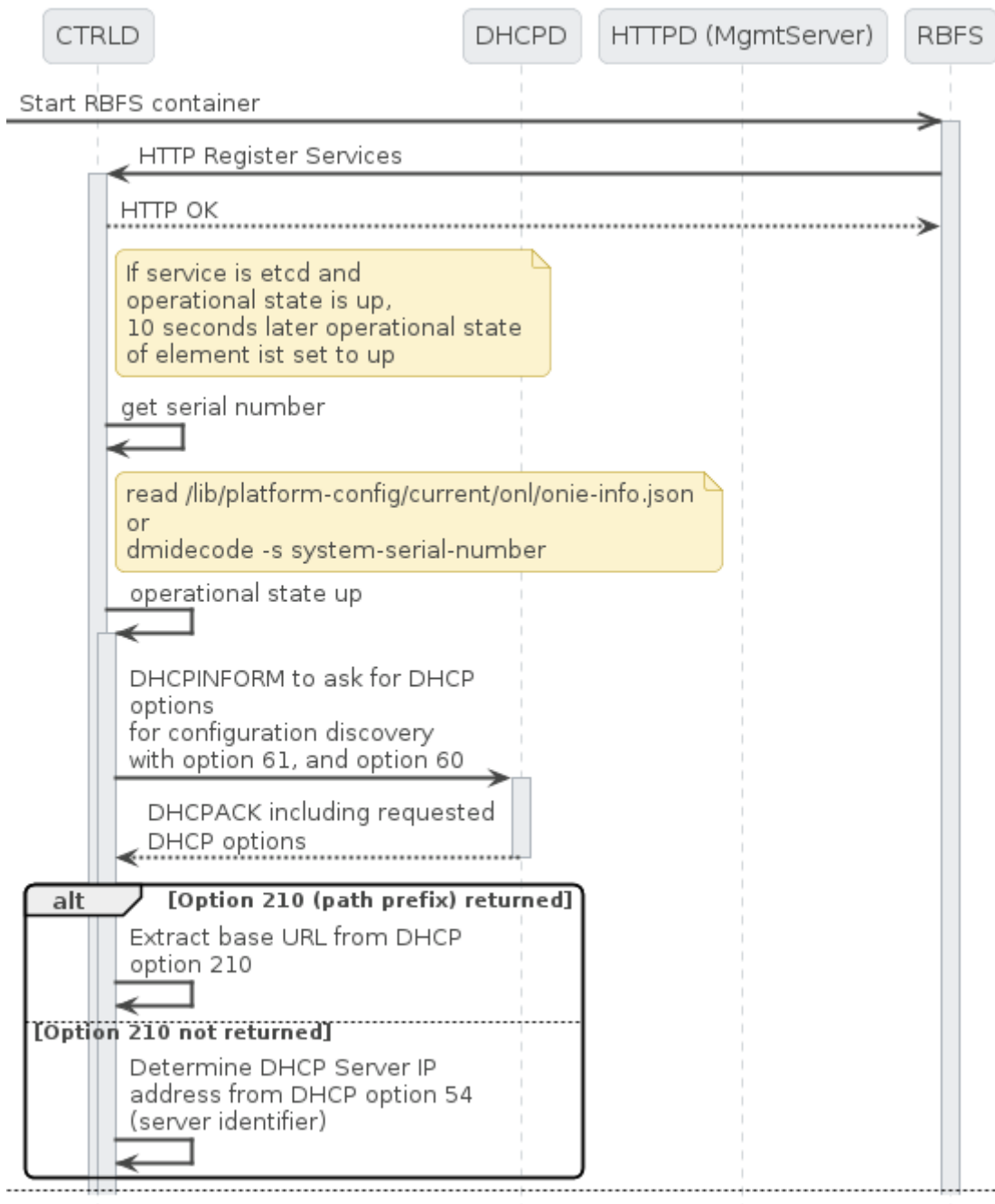


Figure 3. CTRLD ZTP process flow (Part 1/2)

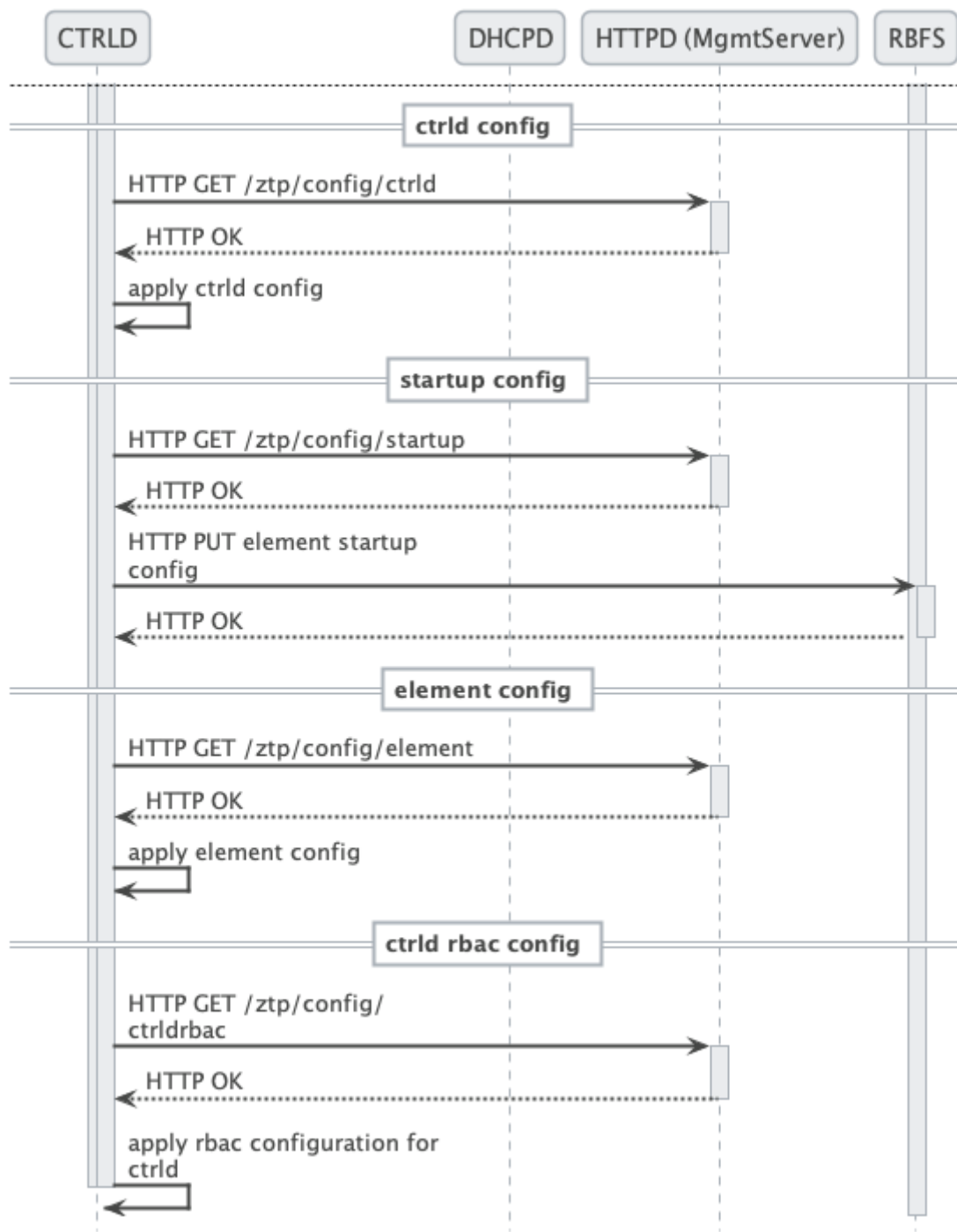


Figure 4. CTRLD ZTP process flow (Part 2/2)

## References

### References

/ONIE/	Open Network Installation Environment Image Discovery
/RFC2131/	RFC2131 - Dynamic Host Configuration Protocol
/RFC2132/	RFC2132 - DHCP Options and BOOTP Vendor Extensions <a href="https://tools.ietf.org/html/rfc2132">https://tools.ietf.org/html/rfc2132</a>



/RFC5071/	RFC5071 - Dynamic Host Configuration Protocol Options Used by PXELINUX
/ISCKB/	ISC Default DHCP Options

## 3. RBFS Licensing

### Overview

RBFS Licensing allows you to access the full functionality of your RtBrick FullStack (RBFS) installation. Rtbrick provides a 28-day evaluation license on request. It is not allowed to be used in production. Use a permanent or subscription license that has been purchased through RtBrick Sales. If you want to extend the evaluation period and get additional licenses, contact RtBrick Support.

Without any license installed on your system, you can evaluate RBFS for 7 days. You need to get an evaluation license or purchase an actual license within 7 days to use the full functionality of RBFS.

### Obtaining or Extending Licenses

To obtain new RBFS licenses or extend the existing licenses, go to <https://portal.rtbrick.com/>, click **Licenses** in the left navigation pane, and then select the **Request license** link.

### Installing a License

You can install a license by using the RBFS CLI or via the RESTCONF API. You should get a license encrypted string from Rtbrick and configure the same via CLI.



When you upgrade your RBFS installation, the existing license should either get restored via saved configuration or it needs to be installed again.

To install a license, enter the following command:

#### Syntax

```
set system license <license_key>
```

## Example

```
supervisor@rtbrick: cfg> set system license
"eyJzdGFyZDk5YXR1IjogMTYxNTg3MTE3MCwgImVuZGF9kYXR1IjogMTYxNTk1NzU3MH0=.Yx/XiFDFRzAt
XPUOaIoh5GqiXa+kOJBWp3LgDeJooVrl88mpPs2ZRMPC+k5HvoZDXvsreqRrqr3vk7S2PlqmLxYf0bNB
ly4dlhrloBwwFkFuJaiU/M+ZGPEXgILdVyXumI88VYx8m/Z5SxEj0bFQGUY8UHRUYW/Ay8fhPfYe jWuSgp
v3OrIThH9CVjldmrp/k4yOuHyTz5gLGq4A0h33vB5O99aOIJW5UX4XDKvQqmX5kytRlR1SseWuAbWKjUd
VOKf2Mk36IbF9/xAKier++LzXESpLMI+MT63AybSDHOBZydoMjLH9C6cPEfGHZWTIBNtT3679Tokf25EK1
Jw=="
```

The following example shows the running configuration.

```
supervisor@rtbrick: cfg> show config system
{
  "rtbrick-config:system": {
    "license": [
      {
        "license-key":
"eyJzdGFyZDk5YXR1IjogMTYxNTg3MTE3MCwgImVuZGF9kYXR1IjogMTYxNTk1NzU3MH0=.Yx/XiFDFRzAt
XPUOaIoh5GqiXa+kOJBWp3LgDeJooVrl88mpPs2ZRMPC+k5HvoZDXvsreqRrqr3vk7S2PlqmLxYf0bNB
ly4dlhrloBwwFkFuJaiU/M+ZGPEXgILdVyXumI88VYx8m/Z5SxEj0bFQGUY8UHRUYW/Ay8fhPfYe jWuSgp
v3OrIThH9CVjldmrp/k4yOuHyTz5gLGq4A0h33vB5O99aOIJW5UX4XDKvQqmX5kytRlR1SseWuAbWKjUd
VOKf2Mk36IbF9/xAKier++LzXESpLMI+MT63AybSDHOBZydoMjLH9C6cPEfGHZWTIBNtT3679Tokf25EK1
Jw=="
      }
    ]
  }
}
```

## Installing Multiple Licenses

You can install multiple licenses. Additional licenses can be installed even when you have existing license(s). The license with the maximum evaluation period will be prioritised over others. When you have multiple evaluation licenses installed, the one that expires later takes higher priority compared to the other licenses.

## Viewing the installed license

### Syntax

```
show system license
```

## Example

```
root@rtbrick: cfg> show system license
License Validity:
  License 1:
    Start date : Tue Mar 16 05:06:10 GMT +0000 2021
    End date   : Wed Mar 17 05:06:10 GMT +0000 2021
root@rtbrick: cfg>
```

After verifying the validity of the license, the license file will be installed at the following location:

```
/etc/rtbrick/license/rtbrick-license
```

## Deleting a License

To delete a license, enter the following command:

### Syntax

```
delete system license <license_key>
```

### Example

```
supervisor@rtbrick: cfg> delete system license
"eyJzdGFydF9kYXRlIjogMTYxNTg3MTE3MCwgImVuZGF9kYXRlIjogMTYxNTk1NzU3MH0=.Yx/XiFDFRzAt
XPU0aIoh5GqiXa+kOJBWp3LgDeJooVrl88mpPs2ZRMPC+k5HvoZDXvsreqRrqrFR3vk7S2PlqmLxYf0bNB
ly4d1hrloBwwFkFuJaiU/M+ZGPEXgILdVyXumI88VYx8m/Z5SxEj0bFQGUy8UHRUYW/Ay8fhPfYe jWuSgp
v3OrIThH9CVj1Dmrp/k4yOuHyTz5gLgq4A0h33vB5O99aOIJW5UX4XDKvQqmQX5kytRlR1SseWuAbWKjUd
VOKf2Mk36IbF9/xAKier++LzXESpLMI+MT63AybSDHOBZydoMjLH9C6cPEfGHzWTIBNtT3679Tokf25EK1
Jw=="
```

## License Expiry

When a license expires, you will not be able see the operational state of the system via CLI or BDS API.

## License Validation

The process of verifying the validity of the software license is known as license validation. If no license is installed, a 7-day evaluation period will be provided.

During this time, there will be no license validation. After the evaluation period ends, the system will check perform license validation every 12 hours. If a valid license is not found, access to the operational state of the system via CLI or BDS API will not be available.

Once a license is installed on the device, it will be validated every 12 hours. If a license is installed within 7 days of evaluation, it is considered the end of the evaluation period, and the license validation will start from that point onward.

Relevant warning or error messages will be generated based on the license validation:

- A warning is generated if the license validity is less than seven days.
- An error message is generated if the license validity is less than one day.
- A critical message is generated if the license has already expired.

Both BDS and file logs are generated for license expiry, and if the Graylog plugin is configured, they are sent to the Graylog. For a list the logs related to license expiry, refer to the section [License Log Messages](#).

To find out the details about the license installed on your system, run the “show system license” command as explained in the section [Viewing the installed license](#).

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