Cisco IOS XR Setup and Upgrade Guide for Cisco 8000 Series Routers

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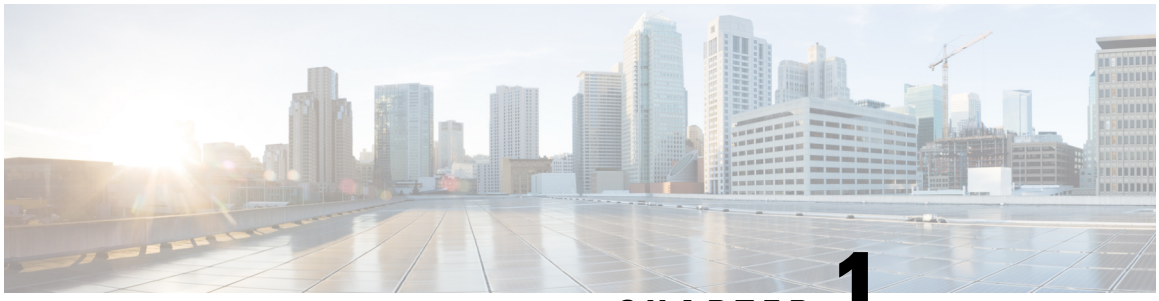


CHAPTER 1

Key Concepts

Use this information to understand the key terms, concepts, types of releases relevant to setting up and upgrading Cisco IOS XR software on Cisco 8000 series routers.

This section contains the following topics:

Key Terms and Concepts

Applicable Variants for Cisco 8000 Series Routers

The Cisco 8000 series routers run on IOS XR software with XR7 architecture. The procedures for setting up and upgrading the software are applicable for these variants of the series:

- Cisco 8201
- Cisco 8202
- Cisco 8808
- Cisco 8812
- Cisco 8818

Setup

When the router with the pre-installed software is powered ON for the first time, the pre-installed version of the IOS XR software starts functioning automatically. You set up and configure the router for network capabilities.

Upgrade

When a new version of the IOS XR software is available, you may choose to upgrade to that version.

Upgrade Methods

After your upgrade, you apply the changes by using one of two methods:

- Process restart – the system is upgraded while it's in service by restarting only those processes that are affected by the upgrade. This applies to Software Maintenance Upgrades (SMUs).

  However, some SMUs can be applied during system reload as well.

- Drain and reboot – traffic is drained before the upgrade and changes are applied by reloading the router with the updated version.

Packages and Red Hat Package Manager (RPM)

Cisco uses the Red Hat Package Manager (RPM) package management system to package required and optional files for installing and upgrading the IOS XR software.

Base Image and Optional Packages

The .iso is the bare minimum software image that is required to run IOS XR on the router. Additional IOS XR packages are optional and are needed depending on the router configuration and required features. If you wish to add features like multicast, manageability, BNG, you must install the appropriate optional package.

Customizable ISO or Golden ISO (GISO)

Golden ISO (GISO) is a customized ISO image that is built to contain preferable packages to suit diverse installation requirements. GISO can be customized to include a standard base image with the basic functional components, additional RPMs, bug fixes, and configuration files based on your requirement.

Active and Committed Packages

An *active package* is the software version on the router after a version upgrade. If the upgraded version is to be retained after reloads, you need to *commit* the changes. After committing the changes, the active packages would then match the list of committed packges retained till the next applicable install upgrade or downgrade operation, or until the install package-based operations are carried out.

Operation

An operation is the sum of all work carried out to fulfill a user’s request provided through CLIs or RPCs.

The internal work performed to complete an operation is regarded to be at different levels of operation: transactions, atomic software changes, and packaging operations.

Each operation is assigned an Operation ID, which is a function of one of these:

Table 1: Operation IDs

Operation ID	Function
1	Transaction ID
1.1	Transaction ID and the atomic change ID if there is one
1.1.1	Transaction ID, the atomic change ID, and packaging operation ID if there is one

For example, these are operations with their Operation IDs carried out through these commands.

- install package add xr-bgp – **1.1.1** - This is starting the **first** transaction, the **first** atomic operation and the **first** packaging operation.
- install package remove xr-bgp – 1.1.**2** - This is starting a **second** packaging operation, within the first atomic operation in the first transaction.

Transactions

Transactions are the highest level of operation. Starting a transaction marks the start of an overall operation. To maintain the software changes carried out during a transaction, you must commit the transaction. If the system reloads during an install transaction, the running software is reverted to its previous state before the transaction was started. Within a transaction, multiple atomic software changes can be performed.

Atomic Software Changes

All atomic changes occur within a transaction. During an atomic software change, any changes to install IOS XR software are not visible to the system. The changes become visible when the atomic change is applied. Within an atomic operation, multiple packaging operations can be performed.

An atomic operation occurs in its entirety, or does not occur it all. During an upgrade, there is a switchover from the old software to the new in a single step.

Packaging Operations

Packaging operations are actions performed to change the packages that are installed on the system. Every packaging operation is contained within an atomic change. Atomic changes may contain multiple packaging operations. Examples of packaging operations are upgrade, downgrade, replace, add, or remove packages.

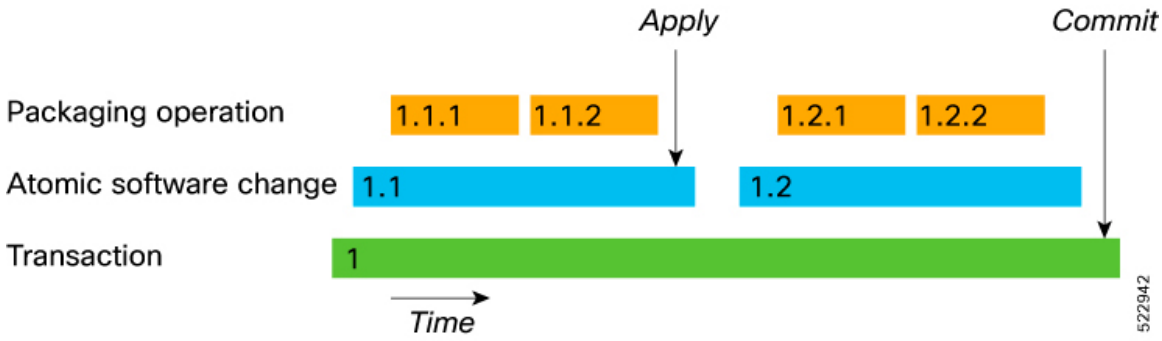
Apply and Commit

One successfully completed operation that modifies the software involves three phases.

- The internal **execution** of the packaging operation that changes the packages that are installed on the system.
- The **Apply** phase that completes an atomic software change and makes the software change visible to the system.
- The **Commit** phase that ends a transaction and ensures that all software changes continue to be present when the router is reloaded.

The following figure shows how the key operations concepts fit together in install and upgrade operations:

Figure 1: Transaction, Atomic Software Change, and Packaging Operation



Example:

- install package add xr-bgp – **1.1.1** This is starting the **first** transaction, the **first** atomic operation and the **first** packaging operation.
- install package remove xr-bgp – 1.1.**2** This is starting a **second** packaging operation, within the first atomic operation in the first transaction.
- install apply - 1.1 This is applying the first atomic operation in the first transaction
- install package add xr-bgp – 1.**2.1**This is starting the **first** packaging operation and the **second** atomic change in the first transaction.
- install package remove xr-bgp – 1.2.**2** This is starting the **second** packaging operation in the second atomic change in the first transaction.
- install apply – 1.2 This is applying the first atomic change in the first transaction.
- install commit - 1This is committing the first transaction
- install package add xr-bgp – **2.1.1** This is starting the **second** transaction, the **first** atomic operation within that transaction and the **first** packaging operation within that atomic operation

Synchronous Action

An asynchronous action allows you to gain access to the prompt and perform another parallel task as the install or upgrade operation continues to its completion.

When installing or upgrading, you can request a synchronous action. Specify the keyword *synchronous* in the install commands, and the prompt is returned only when the request has completed, the Ctrl + C keys are pressed, or a reload occurs.

When the synchronous action is in effect, the user is updated with the status of the request whenever it changes. Pressing Ctrl + C keys during a synchronous action request returns the prompt to the user but does not halt the install or upgrade operation.

Types of Releases

Cisco IOS XR software model has three types of software releases. The software images are available for download at the Cisco Software Download page.

Feature Release

A Feature Release (FR) contains new features and support for new hardware. Feature releases have the X.X.1 (dot one) designation. For example, releases 7.1.1 and 7.5.1 are feature releases. The list of features added to a feature release is provided in the Release notes along with the installation instructions and dependencies.

Maintenance Release

A maintenance release is the primary mechanism to deliver groups of critical bug fixes to the software feature releases.

SMUs Release

A Software Maintenance Unit (SMU) is a fix that is provided until the End of Maintenance (EoM) of the release. The fix is also committed into the next shipping release. SMUs are posted under `Cisco IOS XR Software Maintenance Upgrade` on the Cisco Software Download page. Each SMU is customized for a specific software release.

For more information on release numbering, types of releases, and their timelines, see Software Lifecycle Support Statement - IOS XR.

Files in Cisco Software Download Page

The following table describes the files available for download from the Cisco Software Download page for each variant of the Cisco 8000 series routers:

Table 2: IOS XR Software Installation Files in Cisco Software Download Page

Package File	Example	Description
8000-x64-<*rel. no.*>.iso	8000-x64-7.9.1.iso	Bootable ISO Image of the Operating System required to run IOS XR on a device for basic operations
8000-usb_boot-<*rel. no.*>.zip	8000-x64-usb-7.9.1.zip	USB Boot image of the Operating System
8000-optional-rpms. <*rel. no.*>.tar	8000-optional-rpms.7.9.1.tar	Optional RPMs that provide additional functionality
8000-k9sec-rpms. <*rel. no.*>.tar	8000-k9sec-rpms.7.9.1.tar	Security package that includes software that uses encryption (e.g. SSH) and has export controls for downloads of this software

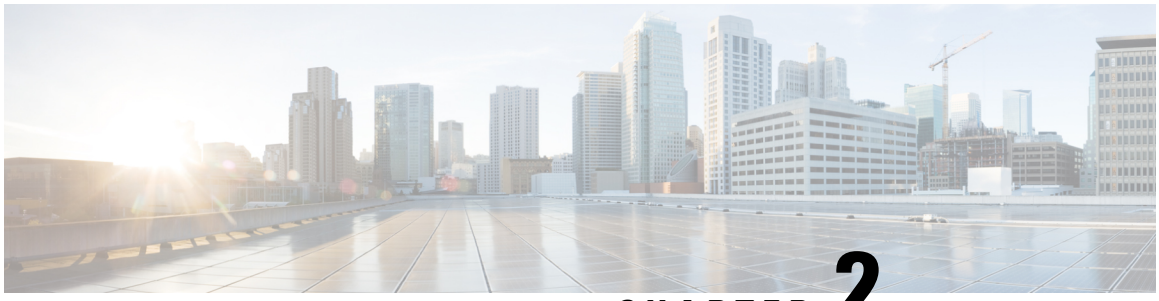
Package File	Example	Description
8000-<*rel. no.*><*bug-ID*>.tar)	8000-7.9.1.CSCvy99756.tar	Optional or recommened SMUs

Command Modes

The router runs on virtualized Cisco IOS XR software. Therefore, the CLI commands must be executed on virtual machines, namely the XR LXC and the System Admin LXC.

The command modes are applicable for the Cisco Series Routers. This table lists the command modes for the LXCs.

Command Mode	Description
XR EXEC mode (XR LXC execution mode)	Run commands on the XR LXC to display the operational state of the router. Example: `RP/0/RP0/CPU0:router#`
XR Config mode (XR LXC configuration mode)	Perform security, routing, and other XR feature configurations on the XR LXC. Example: `RP/0/RP0/CPU0:router#`**`configure`** `RP/0/RP0/CPU0:router(config)#`
(System Admin LXC execution mode)	Run commands on the System Admin LXC to display and monitor the operational state of the router hardware. The chassis or individual hardware modules can be reloaded from this mode. Example: `RP/0/RP0/CPU0:router#`**`admin`** `sysadmin-vm:0_RP0#`
System Admin Config mode (System Admin LXCconfiguration mode)	Run configuration commands on the System Admin LXC to manage and operate the hardware modules of the entire chassis. Example: `RP/0/RP0/CPU0:router#`**`admin`** `sysadmin-vm:0_RP0#`**`config`** `sysadmin-vm:0_RP0(config)#`



CHAPTER 2

Workflow to Setup and Upgrade the Router

The setup and upgrade process depends on several factors. Each process is composed of a series of tasks, forming a linear progression that guides you through completing the tasks. Although there may be differences in certain tasks depending on a specific scenario, some tasks are common across multiple journeys.

The processes are outlined in the following topic:

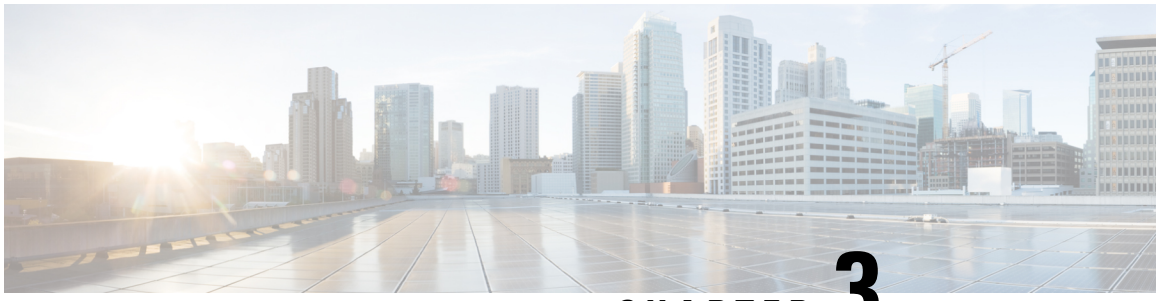
- Setup and Upgrade Workflow, on page 7

Setup and Upgrade Workflow

The workflow provides a high-level view of the steps involved in the setup and upgrade process. This workflow helps you in planning the tasks and minimizing the risk of errors or downtime.

Figure 2: Workflow to Setup and Upgrade the Router

With an understanding of this end-to-end workflow, you can get started with setting up and upgrading the IOS XR software on your Cisco 8000 series routers.



CHAPTER 3

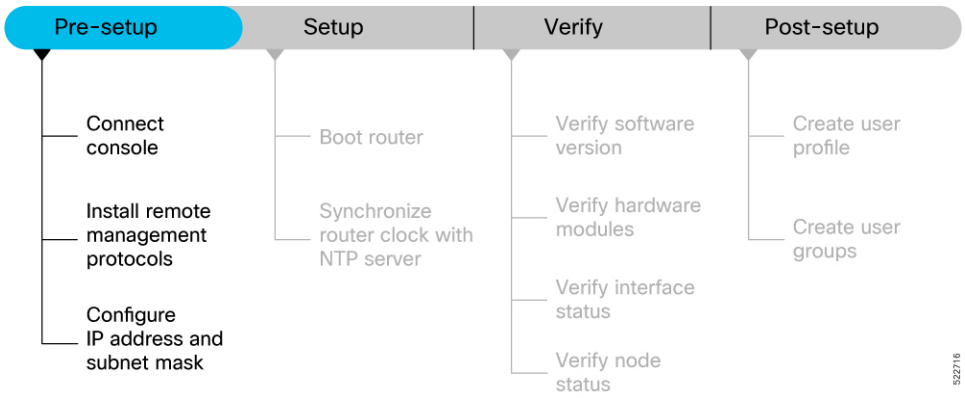
Setup the Router

By following the guidelines provided on this page, you can set up the Cisco 8000 series routers quickly and efficiently.

Prerequisites to Setup Router

Complete the following prerequisite tasks to prepare the router for seamless setup.

Figure 3: Pre-setup Workflow for the Cisco 8000 Series Routers



This section contains the following topics:

Connect Console Port to Terminal

The console port on the router is used to log into a router directly without a network connection using a terminal emulation program like HyperTerminal.

Step 1 Connect the router to a terminal.

a) Locate the console port on the router.

Figure 4: Connect the Router to a Terminal

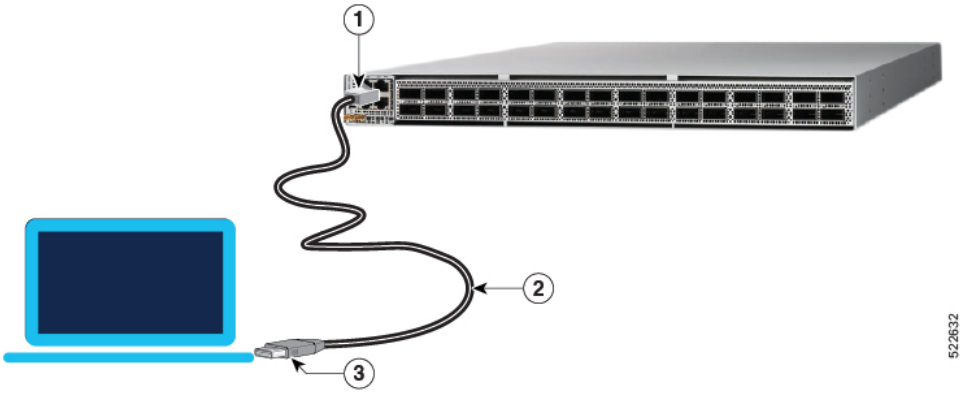


Table 3: Console Port and Cable Specifications

1	Routers console port
2	RJ-45 Rollover cable
3	• RJ-45/DSUB R/P adapter • RJ-45F/DB9F adapter • RJ-45/DSUB F/F adapter

b) Connect the console (or rollover) cable to the console port on the router.
c) Use the correct adapter to connect the other end of the cable to your terminal or PC.

Step 2 Configure the console port to match the following default port characteristics.

a) Launch the terminal session.
b) In the **COM1 Properties** window, select **Port Settings** tab, and enter the following settings:

- Speed – 115200
- Data Bits – 8
- Parity – none
- Stop bits – 1
- Flow Control – none

Step 3 Click **OK**.

You should see a blinking cursor in the HyperTerminal window indicating successful connection to the console port.

Install Remote Management Protocols

The router can be accessed using remote management protocols, such as SSH, SCP, FTP, and Telnet. The SSH, SCP, and FTP management protocols are included in the ISO image by default. Telnet is an optional package.

Install the remote management protocols.

To install Telnet, you can use either of the following options:

- Install telnet package from the local directory of your router. The path to the local directory must be under `/harddisk:/` location. The following example shows how you can install the `xr-telnet-7.0.11v1.0.1-1.x86_64.rpm` optional package:

```
Router#install source /harddisk:/files xr-telnet-7.0.11v1.0.1-1.x86_64.rpm
```

- Install telnet package from a configured repository.

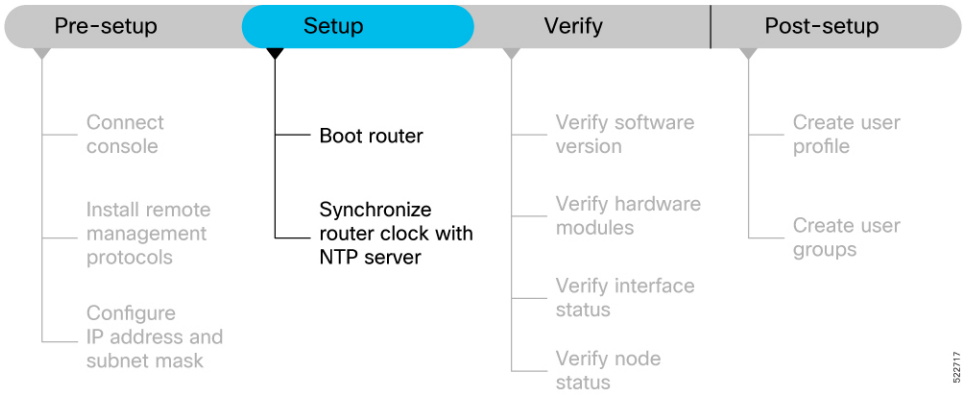
```
Router#install source install-repo xr-telnet
```

For information on creating and accessing an external or local repository, see Create Repository to Access Install Files, on page 37.

Setup the Router

Complete the following tasks to bring up your router for further configurations.

Figure 5: Setup Workflow for the Cisco 8000 Series Router



Boot the Router

After installing the hardware and connecting the console port to the terminal, boot the Cisco 8000 series router. The router completes the boot process using the pre-installed operating system image.

Before you begin

Ensure that you have completed the Prerequisites to Setup Router, on page 11.

Step 1 Power ON the router.

The router completes the boot process using the pre-installed operating system image. If the router is not pre-installed with an image, you can boot the router using PXE boot an externally bootable USB drive or PXE boot.

Step 2 After booting is complete, follow the prompt to create a username and password. This credential is used to log on to the IOS XR console and get to the router prompt. The following prompt appears:

```
!!!!!!!!!!!!!!!!!!!! NO root-system username is configured. Need to configure root-system username.
 !!!!!!!!!!!!!!!!!!!!

--- Administrative User Dialog ---


Enter root-system username:
% Entry must not be null.

Enter root-system username: cisco
Enter secret:
Use the 'configure' command to modify this configuration.
User Access Verification

Username: cisco
Password:
```

See the Recover Router From Boot Failure, on page 100 topic to resolve any boot failure issues.

Configure IP Address and Subnet Mask

Configure the IP address and subnet mask. The IP address and subnet mask for the Management Ethernet interface is used by the router for system management and remote communication.

Consult your network administrator or system planner to procure IP addresses and a subnet mask for the management interface.

Note We recommend that you use a Virtual Private Network (VPN) routing and VPN Routing and Forwarding (VRF) on the Management Ethernet interface.

Step 1 Configure the IP address and a subnet mask for the Management Ethernet interface.

a) Configure the VRF.

Example:

```
Router(config)#vrf vrf1
Router(config-vrf)#exit
```

b) Configure the Management Ethernet Interface and set the VRF and IP address.

Example:

```
Router(config)#interface MgmtEth0/RSP0/CPU0/0
Router(config)#vrf vrf1
Router(config-if)#ipv4 address 10.10.0.1 255.0.0.0
Router(config-if)#ipv4 virtual address vrf vrf1 10.10.0.1/8
```

Configure multiple interfaces in a similar way.

c) Ensure that all available interfaces are discovered, and they in UP state.

Example:

```
Router(config-if)#no shutdown
Router(config-if)#exit
```

d) Configure a static route for communications with devices on other networks. Specify the IP address of the default gateway.

Example:

```
Router(config)#router static vrf vrf1 address-family ipv4 unicast 0.0.0.0/0 10.10.0.1
Router(config)#commit
```

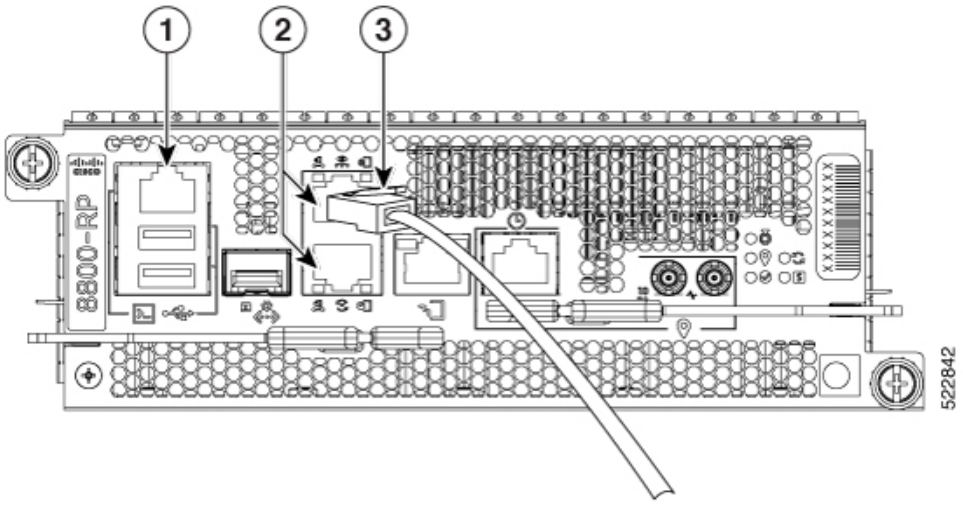
e) SSH into the management port.

Example:

```
Router#conf t
Router(config)#ssh server v2
Router(config)#commit
```

Step 2 Connect the management port to the Ethernet network. The physical port **Ethernet 0** on route processor is the management port.

Figure 6: Console Port and Management Ethernet Port



1	Console RS-232 Serial Port RJ-45
2	Management Ethernet Port (10/100/1000-Mbps) RJ-45 (Copper) port
3	Management Port connected to the Ethernet network

Example:

```
Server# ssh root@10.10.0.1
/etc/ssh/ssh_config line 18: Unsupported option "rhostsrsaauthentication"
/etc/ssh/ssh_config line 19: Unsupported option "rsaauthentication"
Warning: Permanently added 'x.xx.xx.xxx' (ECDSA) to the list of known hosts.
Password:
```

Synchronize Router Clock with NTP Server

You must synchronize the IOS XR clock with the Network Time Protocol (NTP) server to avoid a deviation from true time.

NTP uses the concept of a stratum to describe how many NTP hops away a machine is from an authoritative time source. A stratum 1 time server typically has an authoritative time source (such as a radio or atomic clock, or a GPS time source) directly attached to the server. A stratum 2-time server receives its time through NTP from a stratum 1 time server, and so on.

Note Cisco's implementation of NTP does not support stratum 1 service, and it is not possible to connect to a radio or atomic clock. We recommend that you obtain the time service for your network from the public NTP servers available on the IP Internet.

Step 1 Synchronize the IOS XR clock with NTP server by going through the following example.

Example:

The NTP source is an IP address

```
Router(config)#ntp server NTP-source-IP-address
```

Example of NTP source is an IPv4 address:

```
Router(config)#ntp server 192.0.2.0
```

Example of NTP source is an IPv6 address:

```
Router(config)#ntp server 2001:DB8::1
```

Step 2 Commit the configuration.

Example:

```
Router(config-ntp)#commit
```

Step 3 Verify that the clock is synchronised with the NTP server.

Example:

```
Router#show ntp status
Clock is synchronized, stratum 3, reference is 192.0.2.0 nominal freq is 1000000000.0000 Hz,
actual freq is 1000000000.0000 Hz, precision is 2**24 reference time is E12B1B02.8BB13A2F
(08:42:42.545 UTC Tue Sep 17 2019) clock offset is -3.194 msec, root delay is 4.949 msec
root dispersion is 105.85 msec, peer dispersion is 2.84 msec loopfilter state is 'FREQ'
(Drift being measured), drift is 0.0000000000 s/s system poll interval is 64, last update
was 124 sec ago authenticate is disabled
```

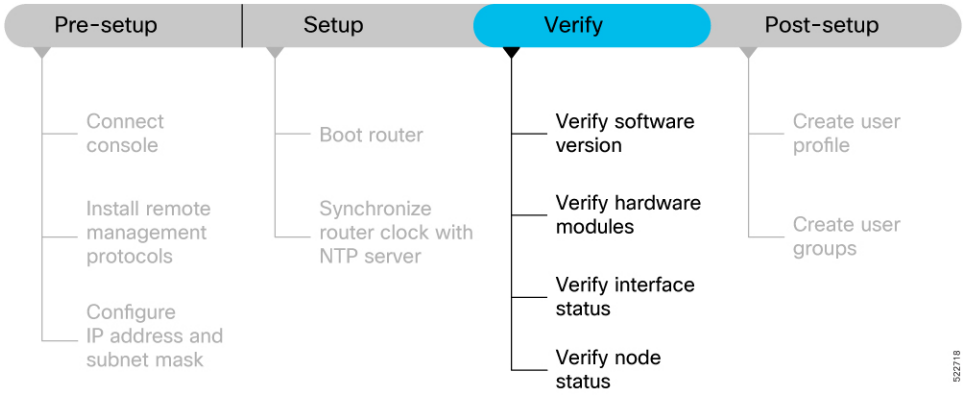
What to do next

Your router is now setup sucessfully. Perform prelimiary checks on the router to verify that the hardware and software components are functional.

Verify the Software and Hardware Status

After logging into the console, perform preliminary checks to verify the default setup.

Figure 7: Verification Workflow for the Cisco 8000 Series Router Setup



Ensure that you have completed the procedures in Setup the Router, on page 13 section before proceeding with the following verification tasks:

Verify Software Version

View the software version installed on the router.

Verify the latest version of the Cisco IOS XR software installed on the router.

Example:

```
Router#show version
Build Information:
Built By : user1
Built On : Thu Feb 02 10:06:56 UTC 2023
Build Host : host
Workspace : /ws
Version : 7.8.1
Label : 7.8.1
```

Note You must upgrade the system if a new version of the system is available to avail the latest features on the router.

For more information about upgrading the software version, see Upgrade the Router, on page 27.

Verify Hardware Modules

Cisco 8000 series routers have various hardware modules such as route processors, line cards, fan trays, and power modules installed on the router. Ensure that the firmware on various hardware components of the router is compatible with the installed Cisco IOS XR image. You also must verify that all the installed hardware and firmware modules are operational.

Step 1 Verify the status of the hardware modules using the **show platform** command.

Example:

```
Router#show platform
Node Type State Config state
--------------------------------------------------------------
0/RP0/CPU0 8201-SYS(Active) IOS XR RUN NSHUT
Provision Network Devices using Zero Touch Provisioning
24
0/RP0/BMC0        8201-SYS            OPERATIONAL         NSHUT
0/PM0             PSU2KW-ACPE         OPERATIONAL         NSHUT
0/PM1             PSU2KW-ACPE         OPERATIONAL         NSHUT
0/FT0             FAN-1RU-PE          OPERATIONAL         NSHUT
0/FT1             FAN-1RU-PE          OPERATIONAL         NSHUT
0/FT2             FAN-1RU-PE          OPERATIONAL         NSHUT
0/FT3             FAN-1RU-PE          OPERATIONAL         NSHUT
0/FT4             FAN-1RU-PE          OPERATIONAL         NSHUT
```

Step 2 View the list of hardware and firmware modules that are detected on the router using the **show hw-module fpd** command.

Example:

```
Router#show hw-module fpd
FPD Versions
=================
Location         Card type     HWver       FPD device      ATR     Status       Running      Programd
-------------------------------------------------------------------------------------------------------
0/RP0/CPU0       8800-RP        0.51       Bios             S       CURRENT      1.15         1.15
0/RP0/CPU0       8800-RP        0.51       BiosGolden       BS      CURRENT      1.15
0/RP0/CPU0       8800-RP        0.51       BmcFitPrimary    S       NEED UPGD    0.240        0.240
0/RP0/CPU0       8800-RP        0.51       BmcFpga          S       NEED UPGD    0.18         0.18
0/RP0/CPU0       8800-RP        0.51       BmcFpgaGolden    BS      CURRENT      0.19
0/RP0/CPU0       8800-RP        0.51       BmcTamFw         S       CURRENT      5.05         5.05
0/RP0/CPU0       8800-RP        0.51       BmcTamFwGolden   BS      CURRENT      5.05
0/RP0/CPU0       8800-RP        0.51       BmcUbootPrimary S       CURRENT      0.15         0.15
0/RP0/CPU0       8800-RP        0.51       EthSwitch                CURRENT      0.07         0.07
0/RP0/CPU0       8800-RP        0.51       EthSwitchGolden BP      CURRENT      0.07
0/RP0/CPU0       8800-RP        0.51       TimingFpga               CURRENT      0.11         0.11
0/RP0/CPU0       8800-RP        0.51       TimingFpgaGolden B      CURRENT      0.11
0/RP0/CPU0       8800-RP        0.51       x86Fpga          S       NEED UPGD    0.23         0.23
0/RP0/CPU0       8800-RP        0.51       x86FpgaGolden    BS      CURRENT      0.24
0/RP0/CPU0       8800-RP        0.51       x86TamFw         S       CURRENT      5.05         5.05
0/RP0/CPU0       8800-RP        0.51       x86TamFwGolden   BS      CURRENT      5.05
```

From the **show hw-module fpd** output, verify that all hardware modules that are installed on the chassis are listed. An unlisted module indicates that the module is either malfunctioning, or has not been installed properly. You must remove and reinstall the hardware module.

The fields in the **show hw-module fpd** output are:

- **FPD Device**: Name of the hardware component, such as IO FPGA, IM FPGA, or BIOS. The Golden FPDs are not field upgradable.

- **Running**: Current version of the firmware running on the FPD.
- **Programd**: Version of the FPD programmed on the module
- **Status**: Upgrade status of the firmware. The different states are:

Table 4: Status and Description of the Firmware Upgrade

Status	Description
CURRENT	The firmware version is the latest version.
READY	The firmware of the FPD is ready for an upgrade.
NOT READY	The firmware of the FPD is not ready for an upgrade.
NEED UPGD	A new firmware version is available in the installed image. We recommend that you to perform an upgrade of the firmware version.
RLOAD REQ	The upgrade is complete, and the ISO image requires a reload.
UPGD DONE	The firmware upgrade is successful.
UPGD FAIL	The firmware upgrade has failed.
BACK IMG	The firmware is corrupt. Reinstall the firmware.
UPGD SKIP	The upgrade is skipped because the installed firmware version is higher than the one available in the image.

Step 3 Upgrade the required firmware as required, using the **upgrade hw-module location all fpd all** command.

Example:

```
Router#upgrade hw-module location all fpd all
Alarms are created showing all modules that needs to be upgraded.

Active Alarms
------------------------------------------------------------------------------------------------------------
Location     Severity  Group      Set Time                  Description
------------------------------------------------------------------------------------------------------------
0/6/CPU0     Major     FPD_Infra  09/16/2019 12:34:59 UTC   One Or More FPDs Need Upgrade Or Not In
 Current State
0/10/CPU0    Major     FPD_Infra  09/16/2019 12:34:59 UTC   One Or More FPDs Need Upgrade Or Not In
 Current State
0/RP0/CPU0   Major     FPD_Infra  09/16/2019 12:34:59 UTC   One Or More FPDs Need Upgrade Or Not In
 Current State
0/RP1/CPU0   Major     FPD_Infra  09/16/2019 12:34:59 UTC   One Or More FPDs Need Upgrade Or Not In
 Current State
0/FC0        Major     FPD_Infra  09/16/2019 12:34:59 UTC   One Or More FPDs Need Upgrade Or Not In
 Current State
0/FC1        Major     FPD_Infra  09/16/2019 12:34:59 UTC   One Or More FPDs Need Upgrade Or Not In
 Current State
```

Note The BIOS and IOFPGA upgrades require a restart of the router for the new version to take effect.

Step 4 Verify status of the modules after upgrade using the **show hw-module fpd** command.

Example:

```
Router#show hw-module fpd
Location      Card type     HWver      FPD device     ATR        Status       Running     Programd
-------------------------------------------------------------------------------------------------
0/RP0/CPU0    8800-RP       0.51       Bios             S          CURRENT    1.15        1.15
```

```
0/RP0/CPU0    8800-RP       0.51       BiosGolden        BS         CURRENT    1.15
0/RP0/CPU0    8800-RP       0.51       BmcFitPrimary     S          RLOAD REQ  0.240       0.241
0/RP0/CPU0    8800-RP       0.51       BmcFpga           S          RLOAD REQ  0.18        0.19
0/RP0/CPU0    8800-RP       0.51       BmcFpgaGolden     BS         CURRENT    0.19
0/RP0/CPU0    8800-RP       0.51       BmcTamFw          S          CURRENT    5.05        5.05
0/RP0/CPU0    8800-RP       0.51       BmcTamFwGolden    BS         CURRENT    5.05
0/RP0/CPU0    8800-RP       0.51       BmcUbootPrimary   S          CURRENT    0.15        0.15
0/RP0/CPU0    8800-RP       0.51       EthSwitch                    CURRENT    0.07        0.07
0/RP0/CPU0    8800-RP       0.51       EthSwitchGolden   BP         CURRENT    0.07
0/RP0/CPU0    8800-RP       0.51       TimingFpga                   CURRENT    0.11        0.11
0/RP0/CPU0    8800-RP       0.51       TimingFpgaGolden  B          CURRENT    0.11
0/RP0/CPU0    8800-RP       0.51       x86Fpga           S          RLOAD REQ  0.23        0.24
0/RP0/CPU0    8800-RP       0.51       x86FpgaGolden     BS         CURRENT    0.24
0/RP0/CPU0    8800-RP       0.51       x86TamFw          S          CURRENT    5.05        5.05
0/RP0/CPU0    8800-RP       0.51       x86TamFwGolden    BS         CURRENT    5.05
```

The status of the upgraded nodes shows that a reload is required.

Step 5 Reload the individual nodes that require an upgrade.

Example:

```
Router#reload location node-location
```

Step 6 Verify that all nodes that had required an upgrade now shows an updated status of CURRENT with an updated FPD version.

Example:

```
Router#show hw-module fpd
FPD Versions
=================
Location     Card type   HWver   FPD device      ATR      Status       Running     Programd
--------------------------------------------------------------------------------------------
0/RP0/CPU0   8800-RP     0.51     Bios            S        CURRENT      1.15        1.15
0/RP0/CPU0   8800-RP     0.51     BiosGolden      BS       CURRENT      1.15
0/RP0/CPU0   8800-RP     0.51     BmcFitPrimary   S        CURRENT      0.241       0.241
0/RP0/CPU0   8800-RP     0.51     BmcFpga         S        CURRENT      0.19        0.19
0/RP0/CPU0   8800-RP     0.51     BmcFpgaGolden   BS       CURRENT      0.19
0/RP0/CPU0   8800-RP     0.51     BmcTamFw        S        CURRENT      5.05        5.05
0/RP0/CPU0   8800-RP     0.51     BmcTamFwGolden  BS       CURRENT      5.05
0/RP0/CPU0   8800-RP     0.51     BmcUbootPrimary S        CURRENT      0.15        0.15
0/RP0/CPU0   8800-RP     0.51     EthSwitch                CURRENT      0.07        0.07
0/RP0/CPU0   8800-RP     0.51     EthSwitchGolden BP       CURRENT      0.07
0/RP0/CPU0   8800-RP     0.51     TimingFpga               CURRENT      0.11        0.11
0/RP0/CPU0   8800-RP     0.51     TimingFpgaGolden B       CURRENT      0.11
0/RP0/CPU0   8800-RP     0.51     x86Fpga          S       CURRENT      0.24        0.24
0/RP0/CPU0   8800-RP     0.51     x86FpgaGolden    BS      CURRENT      0.24
0/RP0/CPU0   8800-RP     0.51     x86TamFw         S       CURRENT      5.05        5.05
0/RP0/CPU0   8800-RP     0.51     x86TamFwGolden   BS      CURRENT      5.05
```

Verify Interface Status

All available interfaces must be discovered by the system after booting the Cisco 8000 Series Router. Interfaces not discovered might indicate a malfunction in the unit.

Use the **show ipv4 interfaces brief** or **show ipv6 interfaces brief** command to view the interfaces discovered by the system.

Example:

```
Router#show ipv4 interfaces brief
Interface              IP-Address        Status         Protocol      Vrf-Name
-------------------------------------------------------------------------------
HundredGigE0/0/0/0     unassigned        Shutdown       Down          default
HundredGigE0/0/0/1     unassigned        Shutdown       Down          default
HundredGigE0/0/0/2     unassigned        Shutdown       Down          default
HundredGigE0/0/0/3     unassigned        Shutdown       Down          default
HundredGigE0/0/0/4     unassigned        Shutdown       Down          default
HundredGigE0/0/0/5     unassigned        Shutdown       Down          default
HundredGigE0/0/0/6     unassigned        Shutdown       Down          default
HundredGigE0/0/0/7     unassigned        Shutdown       Down          default
-------------------------------- <snip> -----------------------------------
TenGigE0/0/0/18/0      unassigned        Up             Up            default
TenGigE0/0/0/18/1      unassigned        Up             Up            default
TenGigE0/0/0/18/2      unassigned        Up             Up            default
TenGigE0/0/0/18/3      unassigned        Up             Up            default
MgmtEth0/RP0/CPU0/0    10.10.10.1        Up             Up            default
```

When a router is turned ON for the first time, all interfaces are in the **unassigned** state.

Ensure that the total number of interfaces that are displayed in the result matches with the actual number of interfaces present on the router, and that the interfaces are created according to the type of line cards displayed in **show platform** command.

Verify Node Status

A node can be a specified location, or the complete hardware module in the system. You must verify that the software state of all route processors, line cards, and the hardware state of fabric cards, fan trays, and power modules are listed, and their state is OPERATIONAL. This indicates that the IOS XR console is operational on the cards.

Verify the operational status of the node using the **show platform** command.

Example:

```
Router#show platform
Node          Type                 State          Config state
--------------------------------------------------------------
0/RP0/CPU0    8800-RP(Active)      IOS XR RUN     NSHUT
0/RP0/BMC0    8800-RP              OPERATIONAL    NSHUT
0/RP1/CPU0    8800-RP(Standby)     IOS XR RUN     NSHUT
0/RP1/BMC0    8800-RP              OPERATIONAL    NSHUT
0/0/CPU0      8800-LC              IOS XR RUN     NSHUT
0/11/CPU0     8800-LC              IOS XR RUN     NSHUT
0/FC0         8800-FC              OPERATIONAL    NSHUT
0/FC3         8800-FC              OPERATIONAL    NSHUT
0/FT0         8800-FAN             OPERATIONAL    NSHUT
0/FT1         8800-FAN             OPERATIONAL    NSHUT
0/FT2         8800-FAN             OPERATIONAL    NSHUT
0/FT3         8800-FAN             OPERATIONAL    NSHUT
0/PT0         FAM7000-ACHV-TRAY    OPERATIONAL    NSHUT
```

Table 5: Card Type, Node Status, and Description

Card Type	State	Description
All	UNKNOWN	Error – Internal card record is not available
All	IDLE	Error – Card state is not initialized
All	DISCOVERED	Card is detected
All	POWERED_ON	Card is powered on
RP, LC	BIOS_READY	Card BIOS is up
RP, LC	IMAGE_INSTALLING	Image is being downloaded or installed
RP, LC	BOOTING	Image is installed and the software is booting up
RP, LC	IOS_XR_RUN	Software is operating normally and is functional
RP, LC	IOS_XR_INITIALIZING	Software is initializing
FC, FT, PT, PM	OPERATIONAL	Card is operating normally and is functional
RP, LC, FC	RESET	Card is undergoing reset
RP, LC	REIMAGE	Card is pending reimage
RP, LC, FC	SHUTTING_DOWN	Card is shutting down as a result of a fault condition, user action or configuration
RP, LC, FC	SHUT_DOWN	Card is shutdown due to a fault condition, user action or configuration
FC	ONLINE	RP is able to access this remote card
LC	DATA_PATH_POWERED_ON	Forwarding complex is powered ON
RP (Active)	SHUTTING_REMOTE_CARDS	Active RP card is in the process of shutting down other cards as part of a chassis reset
RP (Standby), LC, FC	WAITING_FOR_CHASSIS_RESET	Card is shutdown and is waiting for the chassis to be reset
RP, LC	WDOG_STAGE1_TIMEOUT	Card CPU failed to reset the hardware watchdog
RP, LC	WDOG_STAGE2_TIMEOUT	Hardware watchdog has timed out waiting for the card CPU to reset itself

Card Type	State	Description
RP, LC, FC	FPD_UPGRADE	One or more FPD upgrades are in progress
FC	CARD_ACCESS_DOWN	RP is unable to access this remote card
RP (standby only), LC	BOOT HOLD	In a multinode system, any node reloads that occur during a transaction that are not initiated as part of the installation shows a BOOT HOLD state. The node continues to be in this state until the transaction is either committed or cancelled

What to do next

This completes verification of the basic router setup. You can now complete the post-setup tasks where you manage user profiles and groups.

Complete Post-setup Tasks

You must create user profiles and user groups to manage your system, install software packages, and configure your network.

Note Users created in the System Admin VM are different from the ones created in XR VM. As a result, the username and password of a System Admin VM user cannot be used to access the XR VM, and vice versa.

Every user is authenticated using a username and a password. The authentication, authorization, and accounting (AAA) commands help with these services:

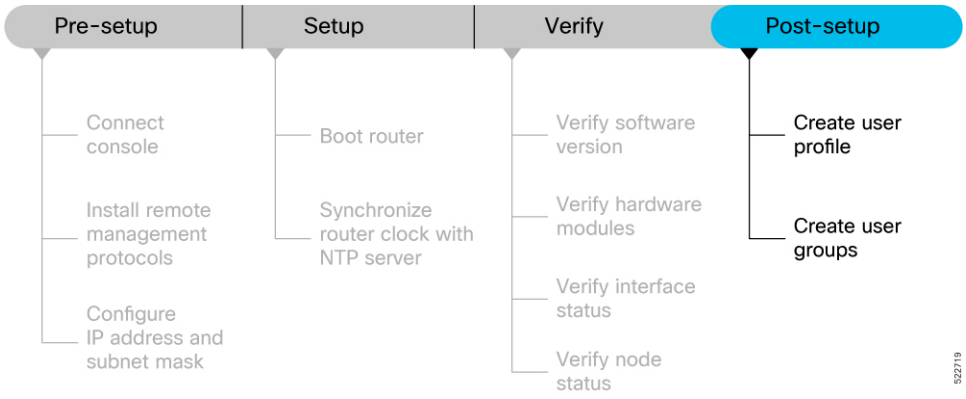
- Create users, groups, command rules, or data rules
- Change the disaster-recovery password

IOS-XR and Linux have separate AAA services and IOS XR AAA is the primary AAA system. A user who is created through IOS-XR can log in directly to the EXEC prompt when connected to the router, while a user created through Linux can connect to the router, but can log in to the bash prompt. The user must log in to IOS XR explicitly, to access the IOS-XR EXEC prompt.

You must configure the IOS-XR AAA authorization to restrict users from uncontrolled access. If AAA is not configured, the command and data rules associated to the groups that are assigned to the user are ignored. A user can have full read/write access to IOS XR configuration through Network Configuration Protocol (NETCONF), google-defined Remote Procedure Calls (gRPC), or any YANG-based agents. To avoid granting uncontrolled access, enable AAA before setting up any configuration. To gain an understanding about AAA, and to explore the AAA services, see the *Configuring AAA Services* chapter in the *System Security Configuration Guide for Cisco 8000 Series Routers*.

The following image provides you an overview of the various tasks that are involved in the Cisco 8000 Series Routers post-setup procedure.

Figure 8: Post-setup Workflow for the Cisco 8000 Series Router



Ensure that you have completed the Setup the Router, on page 13 and Verify the Software and Hardware Status, on page 17 tasks before you perform the following tasks:

Create User Profile

You can create new users and include the user in a user group with certain privileges. The router supports a maximum of 1024 user profiles.

Perform the following steps to create a user profile:

Step 1 Create a user, provide a password and assign the user to a group. For example, **user1** is the user, password is **pw123**, and the group is **root-lr**.

Example:

```
Router#config

/* Create a new user */
Router(config)#username user1

/* Set a password for the new user */
Router(config-un)#password pw123

/* Assign the user to group root-lr */
Router(config-un)#group root-lr
```

All users have read privileges. The **root-lr** users inherit write privileges where users can create configurations, create new users, and so on.

Enable display of login banner: The US Department of Defense (DOD)-approved login banner provides information such as number of successful and unsuccessful login attempts, time stamp, login method, and so on. The banner is displayed before granting access to devices. The banner also ensures privacy and security that is consistent with applicable federal laws. In addition, the system keeps track of logins, right from the system boot, or as soon as the user profile is created.

You can enable or diable the login login banner by using the **login-history enable** and **login-history disable** commands.

Note Login notifications get reset during a router reload.

Step 2 Run the **show running-config username user1** command to verify the state of login banner.

Example:

```
Router(config-un)#show running-config username NAME1
 Fri Jan 29 13:55:28.261 UTC
 username NAME1
 group UG1
 secret * **********
 password * ******
 login-history enable
```

Step 3 Commit the configuration.

Example:

```
Router(config-un)#commit
```

The user profile is created and allowed access to the router based on the configured privileges.

Create User Groups

You can create a new user group to associate command rules and data rules with it. The command rules and data rules are enforced on all users that are part of the user group. The router supports a maximum of 32 user groups.

Before you begin

Ensure that you have created a user profile. See Create User Profile, on page 24.

Step 1 Create a new user group.

Example:

```
Router#config

/* Create a new user group, group1 */
Router#(config)#group group1

/* Specify the name of the user, user1 to assign to this user group */
Router#(config-GRP)#username user1
```

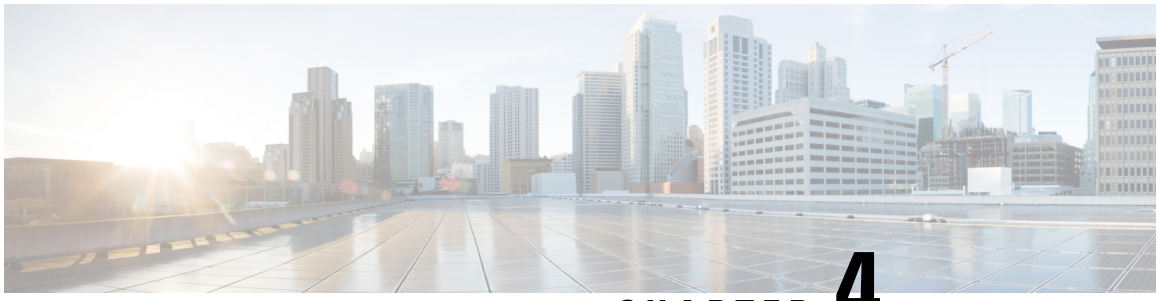
Step 2 Commit the configuration.

Example:

```
Router(config-GRP)#commit
```

What to do next

This completes the router setup and verification process. You can now proceed with upgrading the software, installing RPMs, SMUs and bug fixes based on your requirement.



CHAPTER 4

Upgrade the Router

Your Cisco router comes preinstalled with IOS XR software. You can upgrade the router by installing a new version of the software. We recommend that you keep the software up-to-date to ensure that the router works with the latest features and bug fixes.

During an upgrade:

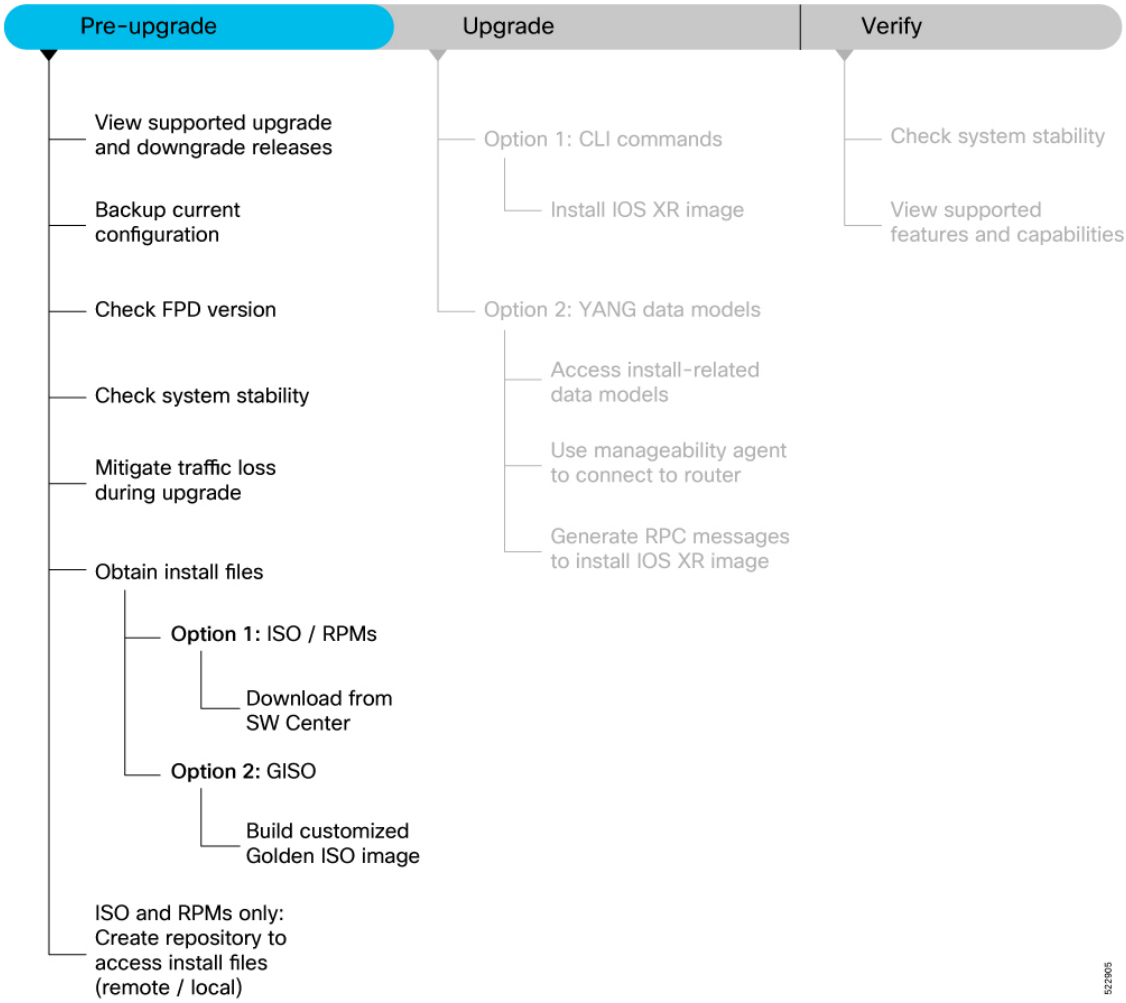
- the newer software replaces the currently active software on the router.
- packages (RPMs) that have the same name and version in the current and target release versions are not removed or reinstalled.

- Plan the Software Upgrade , on page 27
- Upgrade the Software, on page 40
- Verify the Software Upgrade, on page 50

Plan the Software Upgrade

Before you upgrade the software version, prepare the router to ensure that the upgrade process is seamless.

Figure 9: Pre-upgrade Workflow for the Cisco 8000 Series Router



This section describes the following processes to prepare your router for an upgrade:

View Supported Upgrade and Downgrade Releases

Before you begin the upgrade, you must identify a Cisco IOS XR release that aligns with Cisco-recommended upgrade paths.

Use the **show install upgrade-matrix running** command to identify a supported target upgrade release, and prerequisites or limitations related to the specific software upgrade or downgrade. This command provides the following information:

- Required bridging SMU RPMs
- Blocking SMU RPMs
- Unsupported hardware
- Caveats or restrictions

In the following example, the output of the **show install upgrade-matrix running** command displays the upgrade restrictions.

```
Router#show install upgrade-matrix running
Matrix: XR version: 7.9.1, File version: 1.0
The upgrade matrix indicates that the following system upgrades are supported from the
current XR version:

From                 To              Restrictions
7.9.1                7.7.1           CSCab54345
7.9.1                7.7.2           -
7.9.1                7.7.3           -
7.9.1                7.7.4            -
7.9.1                7.7.5            -
7.9.1                7.7.6            -
7.9.1                7.8.1            -
```

In this example, you provide the current version and the target version that you want to upgrade the router. The output of the command displays the support information and dependencies between these two releases:

```
Router#show install upgrade-matrix running 7.5.2 7.3.1
Tue May 10 19:33:59.135 UTC

Upgrade matrix information for system upgrade: 7.5.2->7.3.1

XR system upgrade is supported, with the following restrictions:

The following fixes must be installed if any version of the package is installed.
----------------------------------------
Ddts              Name        Version
----------------------------------------
CSCab54345        xr-bgp      7.5.2
```

You can view support information using the following **show** commands or through the operational data.

Command	Description
`show install upgrade-matrix running`	Displays all supported software upgrades from the current version according to the support data installed on the running system
`show install upgrade-matrix running v1 v2`	Displays details about the software upgrades from version 1 to version 2 according to the support data installed on the running system
`show install upgrade-matrix running all`	Displays all supported software upgrades from any version according to the support data installed on the running system
`show install upgrade-matrix iso path-to-ISO`	Displays details about the software upgrade from the current version to the version of the target ISO according to the support data in both the running system and the ISO image
`show install upgrade-matrix iso path-to-ISO v1 v2`	Displays details about the software upgrade from version 1 to version 2 according to the support data in the target ISO image
`show install upgrade-matrix iso path-to-ISO all`	Displays all supported software upgrades from any version according to the support data in the target ISO image
`show install upgrade-matrix iso path-to-ISO running`	Displays details about the software upgrade from the current version to the version of ISO according to the support matrices in both the running system and the target ISO image

Command	Description
`show install upgrade-matrix rollback`	Displays details about the software upgrade from the current version to a version of a specific rollback point (indicated by an ID) according to the support matrices in both the running system and the rollback ID
`show install upgrade-matrix rollback ID v1 v2`	Displays details about the software upgrade from version 1 to version 2 according to the support data in the specific rollback ID
`show install upgrade-matrix rollback ID all`	Displays all supported software upgrades from any version according to the support data in the specific rollback ID
`show install upgrade-matrix rollback running`	Displays details about the software upgrade from the current version to the version of the specific rollback ID according to the support matrices in both the running system and the rollback ID

Backup Current Configuration

The ability to recover from a disaster is an essential part of any system maintenance plan. We recommend you backup the configurations in a secure remote location and verify that the transfer is a success, both before and after upgrade.

Step 1 Create a backup of the running configuration to one of the following locations based on your requirement:

- Copy the configuration to the `harddisk:` location on the router.

```
Router#copy running-config harddisk:/running_config-<mmddyyyy>
Destination filename [running_config-<mmddyyyy>]?
Building configuration...
[OK]
Verifying checksum...  OK (0xDCF1)
```

- Copy the configuration to a remote server. Ensure the router has root access to the server.

```
Router#scp harddisk:/ running_config-<mmddyyyy>
user:password@<ip-address>:<location>
```

Step 2 Verify that the configuration is backed up.

Check FPD Version

The router uses a number of Field Programmable Devices (FPDs) that are crucial for the function of route processors, line cards, shared port adapters (SPAs), SPA Interface Processors (SIPs), and fan trays. Before upgrading the software, check whether the latest FPDs are available on the router.

Note FPD auto-upgrade is enabled by default on the Cisco 8000 series routers. However, we recommend that when updating to IOS XR Release 7.5.1, configure the **fpd auto-upgrade enable** command.

```
Router#show hw-module fpd
```

```
                                                                                FPD Versions
                                                                                ================
Location       Card type   HWver    FPD device          ATR  Status     Running   Programd
-------------------------------------------------------------------------------------------
0/RP0/CPU0     8800-RP     0.51     Bios                S    CURRENT    1.15      1.15
0/RP0/CPU0     8800-RP     0.51     BiosGolden          BS   CURRENT    1.15

0/RP0/CPU0     8800-RP     0.51     EthSwitch                CURRENT    0.07      0.07
0/RP0/CPU0     8800-RP     0.51     EthSwitchGolden     BP   CURRENT    0.07
0/RP0/CPU0     8800-RP     0.51     TimingFpga               CURRENT    0.11      0.11
0/RP0/CPU0     8800-RP     0.51     TimingFpgaGolden    B    CURRENT    0.11
0/RP0/CPU0     8800-RP     0.51     x86Fpga             S    NEED UPGD  0.23      0.23
0/RP0/CPU0     8800-RP     0.51     x86FpgaGolden       BS   CURRENT    0.24
0/RP0/CPU0     8800-RP     0.51     x86TamFw            S    CURRENT    5.05      5.05
0/RP0/CPU0     8800-RP     0.51     x86TamFwGolden      BS   CURRENT    5.05
```

In this example, `x86Fpga` FPD device needs an upgrade. You must ensure that FPDs are upgraded *before* upgrading the router.

Step 1 To manually upgrade FPDs, use the **upgrade hw-module fpd** command.

```
Router#upgrade hw-module location all fpd all
Alarms are created showing all modules that needs to be upgraded.

Active Alarms
-------------------------------------------------------------------------------------------------------------------
Location      Severity     Group        Set Time                    Description
-------------------------------------------------------------------------------------------------------------------

0/6/CPU0       Major       FPD_Infra    09/16/2019 12:34:59 UTC     One Or More FPDs Need Upgrade Or
 Not In Current State
0/10/CPU0      Major       FPD_Infra    09/16/2019 12:34:59 UTC     One Or More FPDs Need Upgrade Or
 Not In Current State
0/RP0/CPU0     Major       FPD_Infra    09/16/2019 12:34:59 UTC     One Or More FPDs Need Upgrade Or
 Not In Current State
0/RP1/CPU0     Major       FPD_Infra    09/16/2019 12:34:59 UTC     One Or More FPDs Need Upgrade Or
 Not In Current State
0/FC0          Major       FPD_Infra    09/16/2019 12:34:59 UTC     One Or More FPDs Need Upgrade Or
 Not In Current State
0/FC1          Major       FPD_Infra    09/16/2019 12:34:59 UTC     One Or More FPDs Need Upgrade Or
 Not In Current State
```

Note BIOS and IOFPGA upgrades require a power cycle of the router for the new version to take effect.

For example:

```
Router#upgrade hw-module location all fpd all
upgrade command issued (use "show hw-module fpd" to check upgrade status)
Router#
```

```
Router#show hw-module fpd
                                                                                FPD Versions
                                                                                ================
Location       Card type   HWver    FPD device          ATR  Status     Running   Programd
-------------------------------------------------------------------------------------------
0/RP0/CPU0     8800-RP     0.51     Bios                S    CURRENT    1.15      1.15
0/RP0/CPU0     8800-RP     0.51     BiosGolden          BS   CURRENT    1.15
0/RP0/CPU0     8800-RP     0.51     EthSwitch                CURRENT    0.07      0.07
0/RP0/CPU0     8800-RP     0.51     EthSwitchGolden     BP   CURRENT    0.07
0/RP0/CPU0     8800-RP     0.51     TimingFpga               CURRENT    0.11      0.11
0/RP0/CPU0     8800-RP     0.51     TimingFpgaGolden    B    CURRENT    0.11
0/RP0/CPU0     8800-RP     0.51     x86Fpga             S    RLOAD REQ  0.23      0.24
0/RP0/CPU0     8800-RP     0.51     x86FpgaGolden       BS   CURRENT    0.24
```

```
0/RP0/CPU0      8800-RP      0.51      x86TamFw           S    CURRENT    5.05       5.05
0/RP0/CPU0      8800-RP      0.51      x86TamFwGolden     BS   CURRENT    5.05
```

Step 2 Reload the individual nodes that require an upgrade by using the **reload location** *node-location* command.

For example:

```
Router#reload location 0/RP0
Proceed with reload?  [confirm]
```

Note The system requests recovery reload by default when the system detects fault. However, if you want to prevent the recovery reload for debugging, use the **hw-module reset auto disable location** command to disable an auto reset mechanism. You can use the **hw-module reset auto disable location** command in global configuration mode.

If you want to re-enable the recovery reload, use the **no hw-module reset auto disable location** command.

Step 3 You can enable **automatic upgrade of FPD** by using the **fpd auto-upgrade enable** command.

To automatically upgrade all FPDs, use:

```
Router(config)#fpd auto-upgrade enable
```

Usage Guidelines—Online Insertion of IMs

When an IM **with a lower FPD version** is inserted, one of the following scenarios apply:

- If `fpd auto-upgrade` is enabled and a new IM is inserted, the system upgrades the IMs FPDs automatically with the latest FPDs.
- If `fpd auto-upgrade` is disabled, no action is required.

Note Cisco **recommends** enabling the `fpd auto-upgrade`. If you disable it, you must manually check the FPD upgrade on the individual nodes using the **show hw-module fpd** command and reload the individual nodes that require an upgrade using the **reload location** *node-location* command.

Usage Guidelines—Online Insertion of RPs

When **fpd auto-upgrade** is enabled and a new RP is inserted, the system upgrades the RP FPDs automatically with the latest FPDs.

Verify that all nodes that required an upgrade show an updated status of `CURRENT` with an updated FPD version using the **show hw-module fpd** command.

Upgrading FPDs Using Yang Data Models

YANG is a data modeling language that helps to create configurations, retrieve operational data and execute actions. The router acts on the data definition when these operations are requested using NETCONF RPCs. The data model handles the following types of requirements on the routers for FPD:

Operational Data	Native Data Model
Auto Upgrade: Enabling or disabling of automatic upgrade of FPD.	Cisco-IOS-XR-fpd-infra-cfg.yang

Check System Stability

System stability checks are essential to measure the efficiency and ability of an upgrade to function over an extended period.

At the EXEC prompt, execute the following commands to assess basic system stability checks before and after the software upgrade.

Command	Reason	Workaround
show platform	Verify that all nodes are in `IOS XR RUN/OPERATIONAL` state	NA
show redundancy	Verify that a standby RP is available, and the system is in `NSR-ready` state	NA
show ipv4 interface brief Or **show ipv6 interface brief** Or **show interfaces summary**	Verify that all necessary interfaces are `UP`	NA
show install active summary	Verify that the proper set of packages are active	NA
show install committed summary	Verify that the proper set of committed packages are same as active	Execute 'install commit' command
clear configuration inconsistency	Verify/fix configuration file system	NA
show hw-module fpd	Ensure all the FPD versions status are CURRENT	Execute `upgrade hw-module fpd` command
show media	Display the current state of the disk storage media	To free up space, remove older .iso image files and bug fix .tar files.

Command	Reason	Workaround
show media | i rootfs	Display the current state of the root filesystem (rootfs). By default, the following files are stored in **rootfs**: • Older config commits • Older .iso image and .tar files for SMUs • All the extracted .tar files	The installation is blocked if it utilizes more than 92% of the disk space on the **rootfs**. To avoid this, we recommend maintaining: • Twice the free space of the .iso image file size when installing the software • At least two and a half times the size of the .tar file when installing SMUs To free up space in **rootfs**: • use the **clear install rollback id** *id* to remove older rollback points • consider storing all user data in the **harddisk:/** location
show inventory	Show chassis inventory information	NA
show logging	Capture show logging to check for any errors	NA

Mitigate Traffic Loss During Upgrade

During an upgrade, any traffic routed through the device is affected. To minimize traffic loss during the upgrade, do the following:

For OSPF, configure the router to advertise a maximum metric so that other devices do not prefer the router as an intermediate hop in their SPF calculations:

```
Router(config-ospf)#max-metric router-lsa
```

For ISIS, set the overload bit for a fixed amount of time. This ensures that the router does not receive transit traffic while the routing protocol is still converging:

```
Router(config-isis)#set-overload-bit on-startup <timeout>
```

Obtain Install Files

You can obtain the install files based on one of the following options that is best suited to your network:

- **Base ISO and Optional RPMs:** You can upgrade the software through the standard method where you install the ISO followed by the required RPMs.
- **Golden ISO:** You can build a customized golden ISO (GISO) image with the base ISO and the required RPMs to automatically upgrade the software.

Standard ISO and RPMs

Download Install Files from Cisco Software Center

Obtain the install files (base ISO and RPMs) for the target release.

Step 1 Access the Cisco Software Download page.

For optimum website experience, we recommend any of the following browsers: Google Chrome, Mozilla Firefox or Internet Explorer.

Step 2 Select the following:

- Product Name: 8000 Series Routers
- Product Variant: For example, 8201 Router.
- Software Type: IOS XR Software or IOS XR Software Maintenance Upgrades (SMU).

Step 3 From the left pane, select the release.

For the selected release, the Software Download page displays the downloadable files. For more information, see Files in Cisco Software Download Page, on page 5.

Step 4 Use your Cisco login credentials to download the files.

Golden ISO

Build Customized Golden ISO Image

Table 6: Feature History Table

Feature Name	Release Information	Description
Build Golden ISO (GISO) Using gisobuild.py Tool	Release 7.5.1	This feature allows you to build your GISO image without support from Cisco. You can now select the install files, add your RPMs, repackage them as a custom image, and install the image. In previous releases, you had to contact Cisco to get your GISO built.

Golden ISO (GISO) is a customized bootable ISO that you can build to suit your network's installation requirement. You can customize the installable image to include the standard base image with the basic functional components, and add additional RPMs, SMUs and configuration files based on your requirement.

GISO image contains the following files:

- base image (ISO) with basic functional components
- optional packages (RPMs) with additional networking functionality

- bug fixes (SMUs)

For Cisco IOS XR Release 7.5.1 or later, you can build your own GISO image using the *gisobuild.py* tool. This tool is available on the Github repository.

For releases earlier than Cisco IOS XR Release 7.5.1, contact Cisco Technical Support to build the GISO.

Note The GISO build tool verifies the RPM dependencies and RPM signatures. The GISO build process fails if the RPM is unsigned or incorrectly signed.

Before you begin

To run and invoke the `gisobuild.py` tool:

1. Ensure that your local environment provides all the required executables for the tool. For the list of executables and their versions, see *Requirements* section in gisobuild toolkit for IOS-XR available in the Github repository.
2. Alternatively, you can also run gisobuild.py tool on a Linux system using docker build mode. This method provides you the option to avoid the above setup. For more information, see the *Invocation* section in the gisobuild toolkit for IOS-XR available in the Github repository.

Step 1 Download all the relevant files to the system where you build GISO image:

- Download the release-specific .iso image and .rpm files from the Cisco Software Download Center. For more information, see Download Install Files from Cisco Software Center, on page 35.
- Download the gisobuild.py tool from the Github repository.

Step 2 Run the `gisobuild.py` script and provide the parameters to build the GISO image. You can provide multiple repositories to the tool.

Example:

```
$ ./giso/src/gisobuild.py --iso <input iso> --repo <rpm repo1 rpm_repo2> --pkglist <pkg1 pkg2 pkg3>

    --xrconfig <config.cfg> --ztp-ini <ztp.ini> --label <label>
    --out-directory <out_directory> --clean
```

The tool uses the input parameters to build the GISO image.

The following example shows building a GISO image using `8000-x64.iso` base image, `xr-cdp`, `xr-telnet` optional packages and with `GISO1` label.

```
$ src/gisobuild.py --iso /ws/8000-x64.iso --repo /ws/optional-rpms/cdp /ws/optional-rpms/telnet
--pkglist xr-cdp xr-telnet --out-directory /ws/giso-out --label GISO1 --docker --clean
Scanning: /ws/optional-rpms/cdp
Scanning: /ws/optional-rpms/telnet
Setting up container environment...
Reuse matching image, cisco-xr-gisobuild:2.3.3
Removing 'old' images with versions: 2.2.0
Running GISO build...
gisobuild.py --yamlfile /dir/cliConfig.yaml
GISO build successful
ISO: /dir/giso/8000-golden-x86_64-7.8.1-GISO1.iso
Size: 1.76 GB
```

```
USB image: /dir/giso/8000-golden-x86_64-usb_boot-7.8.1-GISO1.zip
ISO label: GISO1
Further logs at /logs/gisobuild.log

Done...
Build artefacts copied to /ws/giso
Verifying checksums...
Checksums OK
Container Logs copied to /logs/container
```

You can specify multiple values in the `--repo` option. The values can be .rpm, .tgz, .tar filenames or directories. The RPMs within the .tgz or .tar files are unpacked and used. The RPMs are only used if a version of them is already included in the ISO or if the corresponding package is specified using the `--pkglist` option.

For the `--pkglist` option, provide the name of installable package and not the individual RPM files. For example, to install the CDP ackage, use the `xr-cdp` package and `xr-telnet` package for Telnet. The package covers all the RPMs. If multiple RPMs are available, the latest version of RPM is used by default.

Create Repository to Access Install Files

A **Repository** is a directory where the ISO, RPMs, and their metadata are downloaded. The package manager uses this repository to query the packages.

The repository can either be created locally on the router, or on a remote location that can be accessed through FTP, HTTP, or HTTPS. In a repository, you can create directories based on different Cisco IOS XR platforms, releases or both. You can create and use multiple repositories. The files to be installed can saved in the local repository, remote repository or a combination of both.

Note The Golden ISO (GISO) method does not require you to create a repository. However, you can still install the GISO from a remote repository.

Important Each package is named based on its name, version, software release, and architecture. Hence, any packages that have these attributes in common and differ only by platform are indistinguishable. We recommend that you create different repositories for different platforms and releases.

Create Remote Repository

We recommend that you create an external remote repository that acts as a central repository to be used across devices. This eliminates the need to copy files for future updates to each router individually. It also serves as a single source when new RPMs (bug fixes, packages, updates) are made available.

The remote repository is available only through the Management Ethernet interface of the router. The server hosting the external repository must be able to reach the router using the address of the loopback interface in the VRF. If a VRF has more than one loopback interface, the loopback with the lowest-numbered loopback name is selected. For example, Loopback1 is selected over Loopback2. When using VRF, configure the repository to be reachable using a non-default VRF table. If the repository is reachable through an address in a VRF, specify the name of the VRF.

The following instructions are applicable to Linux distribution systems.

Step 1 Create a directory on the server and copy the ISO and all RPMs. For example, name the directory as `remote-repo`. The router must be able to access this directory through FTP, HTTP or HTTPS protocol.

Step 2 Extract the files if the RPM files are archived (.tar format) or compressed (.tgz or .gz format). The files hierarchically arrange in sub directories under the main directory.

Step 3 Convert the directory to a repository using `createrepo` utility on the Linux server. This action creates a directory named *repodata* with the metadata of all the RPMs.

Example:

```
[node]$createrepo --database /var/www/html/
Saving Primary metadata
Saving file lists metadata
Saving other metadata
Generating sqlite DBs
Sqlite DBs complete

[node]$cd /var/www/html/
[node]$ls repodata
```

Note If you add new packages to the repository, change or remove packages from the repository, you must run the `createrepo` command again to update the metadata. This ensures that the package manager chooses the correct packages.

Step 4 Configure the remote repository on the router.

Example:

For HTTP protocol:

```
Router#config
Router(config)#install repository remote-repo url http://10.194.88.104/<directory-with-rpms>
Router(config)#commit
Thu 02 2022 UTC: config[67542]: Configuration committed by user 'cisco'.
Router(config)#end
```

where:

- `remote-repo` is the repository name.
- `http://10.194.88.104/<directory-with-rpms>` is the HTTP repository URL. Similarly, you can configure FTP or HTTPS repository URL.

Step 5 Verify connectivity to the server and check the contents of the repository.

Example:

```
Router#show install available
Trying to access repositories...
Package        Architecture            Version           Repository
xr-8000-core    x86_64                 7.8.1             remote-repo
xr-core         x86_64                 7.8.1             remote-repo
```

Only the top-level packages that are available in the repository and not part of the active system are displayed. The contents of the repository are displayed only when the configured repository is valid and the RPMs with the updated metadata are present.

System logs record useful information during the creation of the repository. Check the logs to verify that the repository is valid.

Create Local Repository on the Router

The router can also serve as a repository to host the RPMs. However, you must be a `root-lr` user with access to the router shell. Using a local repository removes the need to set up an external server for software installation. In this method, the image files are copied directly to the router and used to create a repository locally.

Note We do not recommend creating a local repository if you are upgrading multiple routers.

Step 1 Create a new directory locally on the router's /harddisk:. For example, name the directory as `new-repo`.

Step 2 Copy the required RPMs and ISO files (using `copy` or `scp` command) to the local directory on the router.

Step 3 Access the shell of the router and untar the RPMs.

Example:

```
Router#run
[node:~]$cd new_repo
[node:~]$tar -xvzf <rpm-name>.tgz
```

Step 4 Exit from the shell.

Step 5 Configure the local repository.

Example:

```
Router#config
Router(config)#install repository local-repo url file:///harddisk:/local_repo
Router(config)#commit
Thu 02 2022 UTC: config[67542]: Configuration committed by user 'cisco'.
Router(config)#end
```

where:

- `new-repo` is the repository name.
- `file:///harddisk:/local_repo` is the local repository URL.

Step 6 Check the contents of the repository.

Example:

```
Router#show install available
Trying to access repositories...
Package        Architecture           Version           Repository
xr-8000-core    x86_64                7.8.1             local-repo
xr-core         x86_64                7.8.1             local-repo
```

Only the top-level packages that are available in the repository and not part of the active system are displayed. The contents of the repository are displayed only when the configured repository is valid and the RPMs with the updated metadata are present.

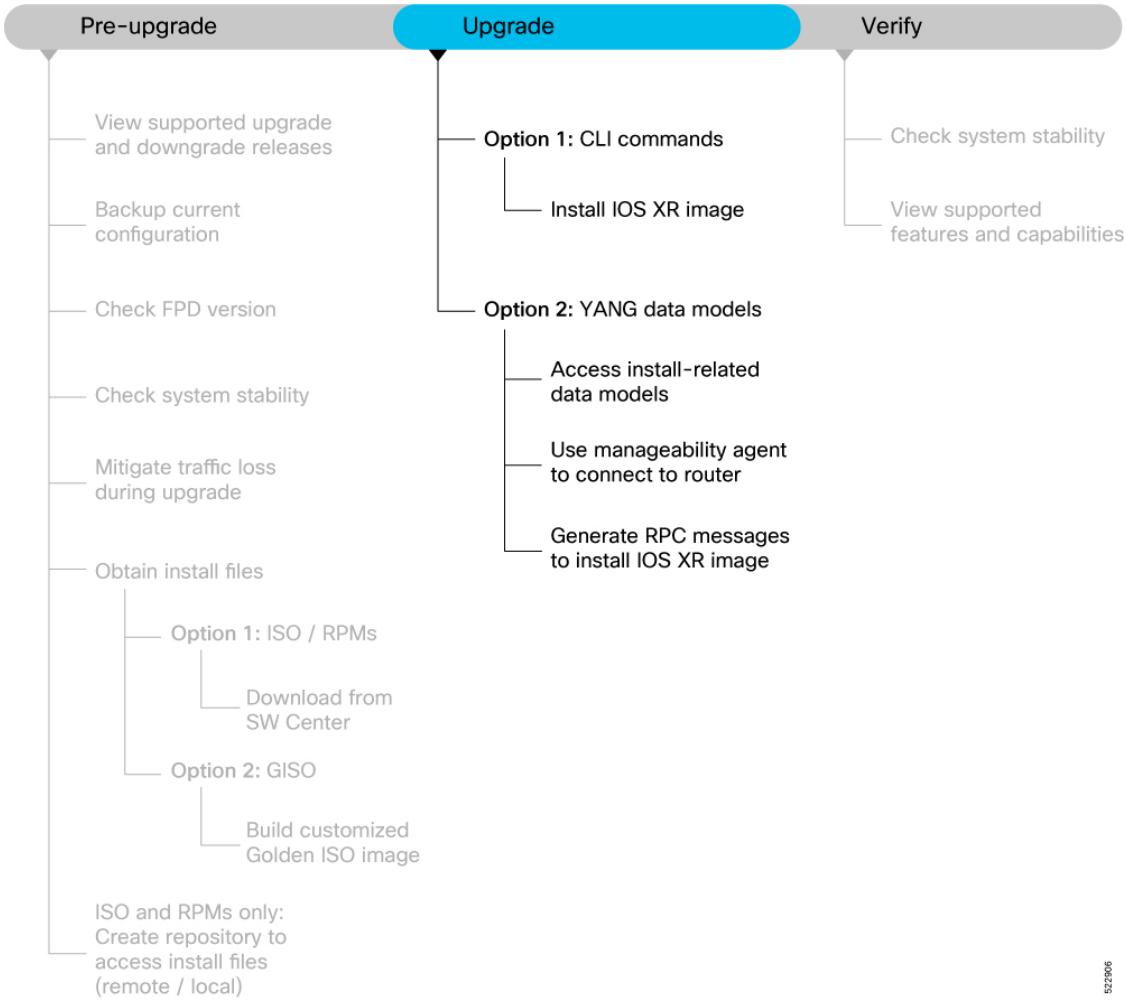
What to do next

The pre-upgrade tasks are complete. Your router is now ready to be upgraded.

Upgrade the Software

This section provides information about the processes involved in upgrading the IOS XR software on your Cisco 8000 series routers.

Figure 10: Workflow to Upgrade the Software



The Cisco IOS XR software can be upgraded using one of these methods:

Upgrade Router Using CLI Commands

There are two options to upgrade your Cisco IOS XR software using the Command Line Interface (CLI):

- Base ISO and optional RPMs

- Golden ISO (GISO)

Install IOS XR Image

Install ISO and RPMs

Use this procedure to install the base ISO and optional RPMs.

Before you begin

Ensure you have created a repository locally on the router or on a remote server which is reachable over HTTP, HTTPS or FTP. This repository will be used to copy the required RPMs. Ensure the router can reach the repository server over the Management Ethernet interface. For information about creating the repository to host the RPMs, see Create Repository to Access Install Files, on page 37.

Step 1 You can either install from the remote repository or copy the ISO image file to the /harddisk: of the router.

Example:

```
Router#scp root@<ip-address>:/<dir>/8000-x64-release.iso harddisk:
```

Step 2 To verify data integrity, verify the md5 checksum of the copied file with the original MD5 values on CCO.

Example:

```
Router#show md5 file /harddisk:/8000-x64-release.iso
```

Step 3 Install the base image to upgrade the system.

- **Option 1:** Install ISO without control over reload timing.

  ```
  Router#install replace /harddisk:/8000-x64-release.iso
  ```

  The image is installed, the changes are applied through a reload or a restart of the system, and commits the changes. However, you do not have control over the timing of the reload or restart —these occur as soon as the package operation completes and the system is ready.

  If you want to control when your system reloads (management of a network outage), we recommend that you schedule an upgrade window and perform an **install replace**, letting the system reload without intervention.

- **Option 2:** Install ISO with control over reload timing.

  a. Install the image.

  ```
  Router#install package replace /harddisk:/8000-x64-release.iso
  ```

  b. Apply the changes.

  ```
  Router#install apply [reload | restart]
  ```

  You can use either the `reload` or `restart` options based on the file that is installed. To determine whether a `reload` or `restart` is required, check the output of **show install request** command. The output indicates the required actions.

Step 4 After the base image is upgraded, install the additional packages. For more information, see Install Additional RPMs and Bug Fixes, on page 88.

If a system fails to boot successfully, or reboots unexpectedly when the package is undergoing a version change, the system is automatically recovered to its old software state.

Note If you perform a manual or automatic system reload without completing the transaction with the **install commit** command, the action will revert the system to the point before the install transaction commenced, including any configuration changes. Only the log is preserved for debugging.

Install Golden ISO

Table 7: Feature History Table

Feature Name	Release Information	Description
Check Integrity of Golden ISO (GISO) Files	Release 7.5.1	This feature enables an automated check during **install package replace** operations to ensure that the files in GISO have not been corrupted. It does so by calculating the md5sum of the files and comparing it against md5sum value that is contained within the GISO that was calculated when the image was built.
Automatic Bridging of Bug Fix RPMs	Release 7.5.1	In earlier releases, any mandatory bridging bug fixes had to be installed separately *before* a GISO upgrade. In this release, this feature allows mandatory bridging bug fixes to be included within the GISO for installation during the GISO upgrade process. This eliminates the older two-step workflow.
IOS XR Configuration File in Golden ISO (GISO)	Release 7.5.1	GISO is a customized image with the standard functional components and additional configuration files. This feature extracts the IOS XR configuration file in GISO and automates the updating of configuration files when the router is reloaded with the new GISO. This feature introduces **iso-config [ignore | replace]** keywords to the **install replace** and **install package replace** commands.

Use this procedure to install the Golden ISO (GISO) that contains the base ISO and a customized list of optional RPMs that you built using the *gisobuild.py* tool. For details, see Build Customized Golden ISO Image, on page 35.

Golden ISO (GISO) upgrades the router to a version that has a predefined list of bug fixes (sometimes also called software maintenance updates) with a single operation.

To update the system to the same release version with a different set of bug fixes:

- Create a GISO with the base version and all the bug fixes you require
- Use the **install replace** or **install package replace** commands to install the GISO.

The GISO can include bridging bug fixes for multiple source releases, and installs only the specific bridging bug fixes required for the target release.

The bridging bug fix RPMs can be used in the following scenarios:

- To resolve a bug that might stop upgrade.
- To meet the prerequisite requirements of a new release version that were not met by the earlier version.

Note The **install replace** command is supported only with GISO, but not with .rpm packages directly.

Step 1 Copy the GISO image file to either the /harddisk: of the router or a repository based on your requirement.

Example:

In this example, the image is copied to the /harddisk: of the router.

```
Router#scp root@<ip-address>:/auto/tftp-test/8000-x64-release.iso harddisk:
```

Step 2 Install the GISO.

- **Option 1:** Install GISO without control over reload timing.

  a. Install GISO to upgrade to a new release, add or remove bugfixes or optional packages.

  ```
  Router#install replace source-location/giso-name.iso
  ```

  The *source-location* can be one of the following locations based on step 1.

  - Local path to the GISO—files located in or under `/var/xr/disk1/`, `/harddisk:/` or `/misc/disk1/`
  - Remote repository—`ftp://<server>[;<vrf>]/<remote_path>` or `http://<server>[;<vrf>]/<remote_path>`

    This command runs the replace operation and applies the new version via router restart or reload, whichever is least impactful, given the change. For example, if you have a GISO that is the same as your base image except one bugfix, and that bugfix can be applied by process restart, the command will install the bugfix and apply by restart, no router reload occurs. However, you do not have control over the timing of the reload or restart—these operations occur as soon as the packaging is complete and the system is ready. If you want to control the timing of system reloads, we recommend that you schedule an upgrade window and run the **install replace** command, allowing the system to reload without manual intervention or network impact.

  b. [Optional] Specify **reload** keyword to force reload for all operations. This may be useful if you want a reliable flow.

c. [Optional] Specify **commit** keyword for the install, apply and commit operations to be performed without user intervention.

- **Option 2:** Install GISO with control over reload timing.

a. Install GISO to upgrade to a new release, add or remove bugfixes or optional packages. The functionality is similar to **install replace** command, except that the staging of packaging changes is performed using this command.

```
Router#install package replace source-location/giso-name.iso
```

The **install package replace** command does not apply the changes.

b. Apply the changes.

```
Router#install apply [reload | restart]
```

You can use either the `reload` or `restart` options based on the change that is installed. You can only apply the changes by restarting the software if the difference between the GISO being installed and the running image is minimal such as bugfixes or package updates.

To determine whether a `reload` or `restart` is required, check the output of **show install request** command. The output indicates the required actions.

Note A GISO label is a string that identifies a GISO. Any install operation, such as adding or removing a package or modifying the software image (replace or package replace) will change the custom label to a system-generated default label. For example:

```
Router#show install active summary
Build Information:
Built By     : user1
Built On     : Thu Feb 02 09:47:56 UTC 2023
Build Host   : host
Workspace    : /ws
Version      : 7.8.1
Label        : GISO1
...
```

In this example, the software image is modified to remove the CDP package.

```
Router#install package remove xr-cdp

Install remove operation 39.1.1 has started
Install operation will continue in the background
...
Packaging operation 39.1.1: 'install package remove xr-cdp' completed without error
```

Apply the changes.

```
Router#install apply
Thu Feb 02 11:13:09.015
Once the packaging dependencies have been determined, the install operation may have to
reload the system.
If you want more control of the operation, then explicitly use 'install apply restart' or
 'install apply reload' as
reported by 'show install request'.
Continue? [yes/no]:[yes] yes
RP/0/RP0/CPU0:Feb 02 11:13:12.771 : instorch[404]: %INSTALL-6-ACTION_BEGIN : Apply by
restart 39.1 started
Install apply operation 39.1 has started
Install operation will continue in the background
```

View the software version.

```
Router#show version
Build Information:
Built By     : user1
Built On     : Thu Feb 02 10:06:56 UTC 2023
Build Host   : host
Workspace    : /ws
Version      : 7.8.1
Label        : 7.8.1
```

The `GISO1` custom label is replaced with the label `7.8.1` generated by the system.

Upgrade Router Using YANG Data Models

Data models are a programmatic way of configuring and collecting operational data of a network device. They replace the process of manual configuration and can be used to automate configuration tasks across heterogeneous devices in a network.

Access Install-related Data Models

You can use YANG data models to install and upgrade the router. The data models are packaged with the release image in the `/pkg/yang` directory.

Step 1 Navigate to the directory in the release image where the YANG data models are available.

Example:

```
Router#run
[node_RP0_CPU0:~]$cd /pkg/yang
```

Step 2 View the list of install-related data models on your router.

Example:

```
node0_RP0_CPU0:/pkg/yang]$ls -ltr *install*
-rw-r--r--.    1    root    root    8646    Jul    2    01:59    Cisco-IOS-XR-install-act.yang
-rw-r--r--.    1    root    root    7267    Jul    2    01:59    Cisco-IOS-XR-install-search-act.yang
-rw-r--r--.    1    root    root    10664   Jul    2    01:59    Cisco-IOS-XR-install-augmented-act.yang
-rw-r--r--.    1    root    root    2511    Jul    2    02:00    Cisco-IOS-XR-um-install-cfg.yang
-rw-r--r--.    1    root    root    2270    Jul    2    02:04    Cisco-IOS-XR-install-cfg.yang
-rw-r--r--.    1    root    root    6222    Jul    2    02:04    Cisco-IOS-XR-install-oper.yang
-rw-r--r--.    1    root    root    14009   Jul    2    02:04
Cisco-IOS-XR-install-augmented-oper.yang
```

The following table describes the function of the install-related data models:

Date Model	Description
Cisco-IOS-XR-um-install-cfg	Unified data model that contains a collection of YANG definitions for Cisco IOS XR install package configuration, and augments the modules with configuration data.
Cisco-IOS-XR-install-oper	Operational data model to view details that are related to basic package information, active and committed packages, and fixes.
Cisco-IOS-XR-install-cfg	Configuration data model to specify the location of the install source.
Cisco-IOS-XR-install-act	Action model to perform basic install operations and software upgrade.
Cisco-IOS-XR-install-search-act	Action model that contains a collection of YANG definitions for install actions related to searching for package information.
Cisco-IOS-XR-install-augmented-oper	Augmented operational model that displays information aboutpackaging, atomic changes, and history of the install operation on the router.
Cisco-IOS-XR-install-augmented-act	Action model to perform flexible install operations, includingcontrolling the exact timing of system reloads and rolling back to a previous commit.
Cisco-IOS-XR-shellutil-copy-act	Action model to copy files on the router from a source location.

You can also access the supported data models to install Cisco IOS XR software from the Github repository.

Use Manageability Agent to Connect to Router

Use a manageability agent like NETCONF or gRPC to connect and communicate with the router. You can send Remote Procedure Calls (RPC) requests to configure or retrieve operational data from the router. The router processes the request and responds to the request through an RPC response. You use the RPCs to send requests to install the software by populating the relevant parameters of a container and leaf in the data model. For more information about understanding the data model structure and using data models, see the *Programmability Configuration Guide for Cisco 8000 Series Routers* .

Generate RPC Messages to Install IOS XR Image

Before you begin

Not all software versions are supported as the target upgrade software version. You must review the supported upgrade and downgrade paths, hardware or software limitations, and bridging SMUs required for the version. For more information about checking the release support between the current and target versions, see View Supported Upgrade and Downgrade Releases, on page 28.

Step 1 Use the `install-replace` RPC on the `Cisco-IOS-XR-install-act.yang` data model to upgrade the router(s).

Step 2 Configure the values of the `source-type`, `source`, and `file` parameters.

Step 3 Send `edit-config` NETCONF RPC request using the data model to configure the repository. Edit the values in the `repositories` parameters and send this request to the router from the client.

Example:

Example:

In this example, the request is to install the `8000-x64-`*`version`*`.iso` image from the local repository.

```
<rpc xmlns="urn:ietf:params:xml:ns:netconf:base:1.0" message-id="101">
  <edit-config>
    <target>
      <candidate/>
    </target>
    <config>
      <install xmlns="http://cisco.com/ns/yang/Cisco-IOS-XR-install-cfg">
        <repositories>
          <repository>
            <id>repo_local</id>
            <url>file:///harddisk:/repo/</url>
            <description>local repository</description>
          </repository>
        </repositories>
      </install>
    </config>
  </edit-config>
</rpc>
```

View the RPC response received from the router.

```
<?xml version="1.0"?>
<rpc-reply message-id="101" xmlns="urn:ietf:params:xml:ns:netconf:base:1.0">
 <ok/>
</rpc-reply>
```

In the response, the router acknowledges the configuration and sends a reply to the client with an `ok` message.

Step 4 Apply the changes to activate the ISO on the router using RPCs by using the `install-apply`RPC on the`Cisco-IOS-XR-install-augmented-act.yang`datamodel and send the RPC from the client to the router.

Example:

```
<rpc xmlns="urn:ietf:params:xml:ns:netconf:base:1.0" message-id="101">
  <install-apply xmlns="http://cisco.com/ns/yang/Cisco-IOS-XR-install-augmented-act">
   <apply-method>least-impactful</apply-method>
  </install-apply>
</rpc>
```

View the RPC response received from the router.

```
<?xml version="1.0"?>
  <rpc-reply message-id="101" xmlns="urn:ietf:params:xml:ns:netconf:base:1.0">
   <op-id xmlns="http://cisco.com/ns/yang/Cisco-IOS-XR-install-augmented-act">2.1</op-id>
  </rpc-reply>
```

In the response, the router sends an ID indicating that the changes are applied successfully.

Step 5 Verify that the software upgrade is successful. Use the `get`RPCon `Cisco-IOS-XR-install-oper.yang`data model. Edit the `install`parameter and send an RPC request from the client to the router.

Example:

```
<rpc xmlns="urn:ietf:params:xml:ns:netconf:base:1.0" message-id="101">
  <get>
   <filter>
    <install xmlns="http://cisco.com/ns/yang/Cisco-IOS-XR-install-oper">
     <request/>
    </install>
   </filter>
  </get>
</rpc>
```

View the RPC response received from the router.

```
<?xml version="1.0"?>
  <rpc-reply message-id="101" xmlns="urn:ietf:params:xml:ns:netconf:base:1.0">
   <data>
    <install xmlns="http://cisco.com/ns/yang/Cisco-IOS-XR-install-oper">
     <request>
      <request>install commit</request>
      <state>success</state>
     <timestamp>2022-06-27 T02:52:07Z</timestamp>
    <operation-id>26</operation-id>
   </request>
  </install>
```

The state of the install operation in the RPC response indicates that the software and the RPMs are upgraded successfully.

What to do next

Perform prelimiary checks to verify that the router is upgraded successfully.

Upgrade QDD Optical Modules

The QDD optics firmware file needs to be copied to the router manually. Contact Cisco Support to check the QDD firmware version, IOS XR release compatibility, and to obtain the QDD optics firmware file.

Starting from Cisco IOS XR Release 7.5.2, you can upgrade the Field-Programmable Device (FPD) for QDD optical modules.

Limitation: When ports share a common management interface, IOS XR serializes the firmware upgrade. Serializing and deserializing may delay the upgrade process.

Step 1 Copy the QDD firmware file to the harddisk: location.

Example:

```
scp user@10.1.1.1:/home/user/filename harddisk:/
```

When you are using VRF, use the following sample command:

```
scp user@10.1.1.1:/home/user/cl1.bin vrf MGMT harddisk:/

Tue Jan 25 02:57:22.762 UTC
Connecting to 10.1.1.1...
Password:
  Transferred 1484800 Bytes
  1484800 bytes copied in 0 sec (22161194)bytes/sec

RP/0/RP0/CPU0:8808#dir harddisk:/cl1.bin
Tue Jan 25 03:00:47.835 UTC

Directory of harddisk:/cl1.bin
35 -rw-r--r--. 1 1484800 Jan 25 02:57 dp04qsdd_dp04sfp8_161_10_01.ackit

53461500 kbytes total (42983204 kbytes free)
```

When you are not using VRF, remove the `vrf MGMT` command:

```
scp user@10.1.1.1:/home/user/cl1.bin harddisk:/
```

Step 2 Upgrade the FPD for QDD optical modules.

Example:

Multiple port upgrade:

```
Router#upgrade optics port 0,1,2,3,4 filename /harddisk:/cl1.bin location 0/1/CPU0
```

Single port upgrade:

```
Router#upgrade optics port 0 filename /harddisk:/cl1.bin location 0/1/CPU0
```

Step 3 Check the firmware upgrade progress.

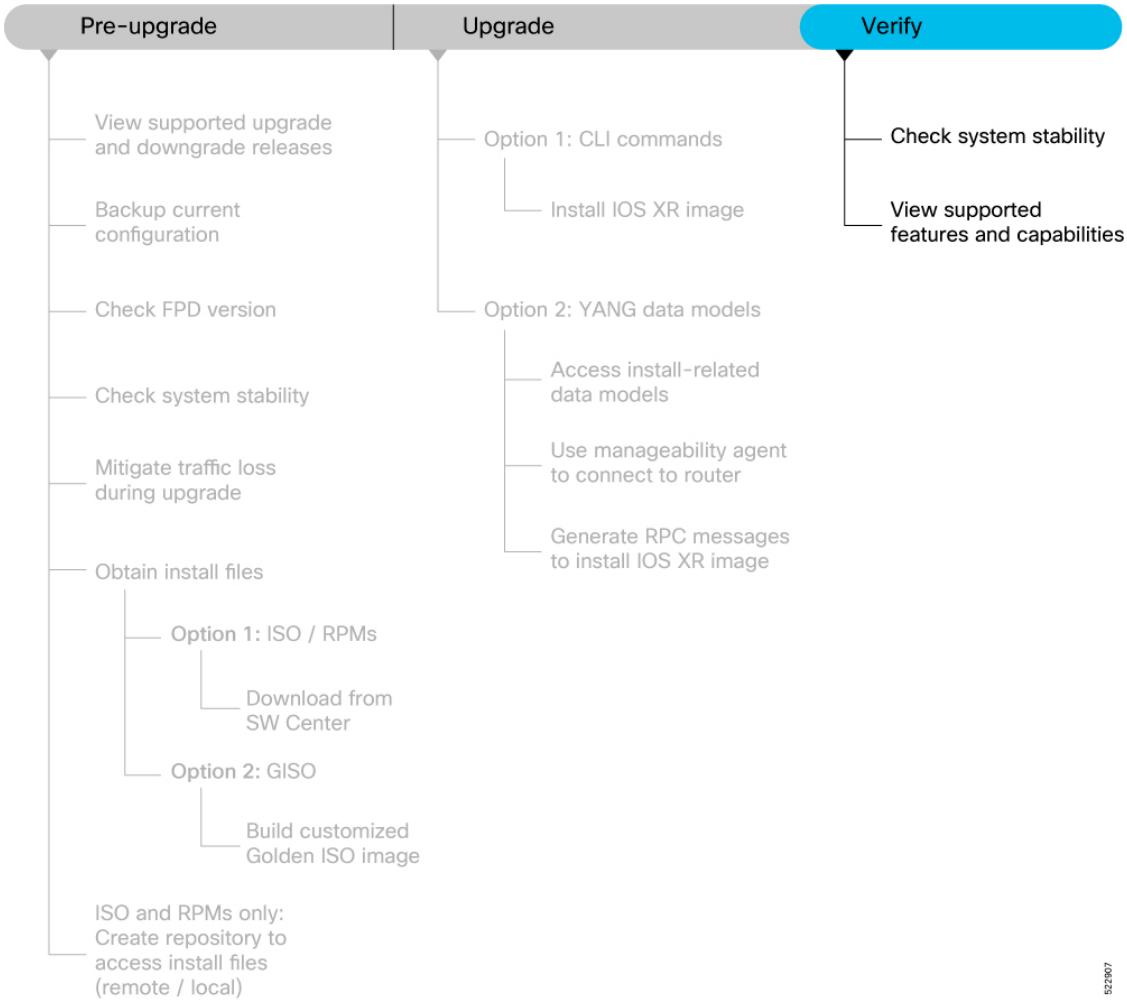
Example:

```
Router#show optics firmware upgrade port 0,1,1,2,3,4 location 0/1/CPU0
```

Verify the Software Upgrade

This section provides information about the processes involved in verifying the upgraded software on your Cisco 8000 series routers.

Figure 11: Workflow to Verify the Software Upgrade



This section contains the following topics:

Check System Stability

System stability checks are essential to measure the efficiency and ability of an upgrade to function over an extended period.

At the EXEC prompt, execute the following commands to assess basic system stability checks before and after the software upgrade.

Command	Reason	Workaround
show platform	Verify that all nodes are in `IOS XR RUN/OPERATIONAL` state	NA
show redundancy	Verify that a standby RP is available, and the system is in `NSR-ready` state	NA
show install active summary	Verify that the proper set of packages are active	NA
show install committed summary	Verify that the proper set of committed packages are same as active	Execute 'install commit' command
clear configuration inconsistency	Verify/fix configuration file system	NA
show hw-module fpd	Ensure all the FPD versions status are CURRENT	Execute `upgrade hw-module fpd` command
show media	Display the current state of the disk storage media	To free up space, remove older .iso image files and bug fix .tar files.
show inventory	Show chassis inventory information	NA

View Supported Features and Capabilities

Table 8: Feature History Table

Feature Name	Release Information	Description
View Supported Features and Capabilities	Release 7.5.2	This functionality displays a list of supported and unsupported features and their capabilities in a release for your router. With this feature, you are better equipped to plan your network configuration with features annotated for their support information. This feature introduces the **show features** command.

This feature provides an answer to the question `Is feature X supported on my router?`

You can determine whether a feature and their capabilities are supported on your router for the release. The support information is based on the release and platform-specific data such as platform variants, RP, or LC present on the router.

Note In Cisco IOS XR Software Release 7.5.2, only the capabilities for Access Control List (ACL) feature is supported.

The functionality to determine the capabilities information is enabled by default when the supported release is installed on the router.

Use the **show features** command to view the list of supported features and their capabilities. The feature capabilities are displayed in a tree structure with notations for the support information. For example, in ACL, the capability to use compression to accommodate a large number of Access Control Elements (ACEs) is supported, whereas IPv6 ACL BNG does not have support data in Cisco IOS XR Software Release 7.5.2. This support information about the feature is represented with the following key in the tree structure:

Key	Capability Support Information	Description
X	Unsupported	The feature capability is not supported on the platform for the release
-	Supported	The feature capability is supported on the platform for the release
?	Support unknown	The support for the feature capability is unknown on the platform for the release. This data could be because the optional package for the feature is not installed on the router.
*	Support data not available	The support for the feature capability is not available on the platform for the release. This data could be because the feature may be specific to a line card that is not present on the router.

View the List of Supported Features

In this example, the supported features on the router are displayed.

Note In Cisco IOS XR Software Release 7.5.2, only the feature capabilities for Access Control List (ACL) is supported.

```
Router#show features
Fri Sep 1 19:16:58.298 UTC
Key:
X - Unsupported
- - Supported
? - Support unknown (optional package not installed)
* - Support data not available

[-] Cisco IOS XR
|--[-] XR Protocols
|  |--[-] XR Base Protocols
|  |  |--[-] Services
|  |  |  |--[-] Access Control List (ACL)
|  |  |  |  |--[-]  IPv6 ACL Support
|  |  |  |  |  |--[*] IPv6 ACL ABF Track
|  |  |  |  |  |--[*] IPv6 ACL BNG
|  |  |  |  |  |--[*] IPv6 ACL Chaining (Meta ACL)
|  |  |  |  |  |--[-] IPv6 ACL Common ACL
|  |  |  |  |  |--[-] IPv6 ACL Compression
|  |  |  |  |  |--[*] IPv6 ACL Default ABF
|  |  |  |  |  |--[*] IPv6 ACL Fragment
|  |  |  |  |  |--[-] IPv6 ACL ICMP Off
|  |  |  |  |  |--[-] IPv6 ACL ICMP Protocol
|  |  |  |  |  |--[-] IPv6 ACL Interface Statistics
|  |  |  |  |  |--[-] IPv6 ACL Log Rate
|  |  |  |  |  |--[-] IPv6 ACL Log Threshold
```

```
|  |  |  |  |  |--[-] IPv6 ACL Logging
|  |  |  |  |  |--[-] IPv6 ACL MIB
|  |  |  |  |  |--[-] IPv6 ACL Object Groups (Scale)
|  |  |  |  |  |--[-] IPv6 ACL Police
|  |  |  |  |  |--[-] IPv6 ACL Priority
|  |  |  |  |  |--[*] IPv6 ACL Protocol Range
|  |  |  |  |  |--[-] IPv6 ACL Set Qos-Group
|  |  |  |  |  |--[-] IPv6 ACL Set TTL
|  |  |  |  |  |--[-] IPv6 ACL TCP Flags
|  |  |  |  |  |--[-] IPv6 ACL TTL Match
|  |  |  |  |  |--[-] IPv6 ACL UDF
|  |  |  |  |--[-] ES-ACL Support (L2 ACL)
|  |  |  |  |--[-] IPv4 ACL Support
|  |  |  |  |  |--[-] IPv4 ACL  Set Qos-group
|  |  |  |  |  |--[*] IPv4 ACL ABF Track
|  |  |  |  |  |--[*] IPv4 ACL BNG
|  |  |  |  |  |--[*] IPv4 ACL Chaining (Meta ACL)
|  |  |  |  |  |--[-] IPv4 ACL Common ACL
|  |  |  |  |  |--[-] IPv4 ACL Compression
|  |  |  |  |  |--[*] IPv4 ACL Default ABF
|  |  |  |  |  |--[*] IPv4 ACL Fragment
|  |  |  |  |  |--[-] IPv4 ACL Fragment Flags
|  |  |  |  |  |--[-] IPv4 ACL ICMP Off
|  |  |  |  |  |--[-] IPv4 ACL ICMP Protocol
|  |  |  |  |  |--[-] IPv4 ACL Interface Statistics
|  |  |  |  |  |--[-] IPv4 ACL Log Rate
|  |  |  |  |  |--[-] IPv4 ACL Log Threshold
|  |  |  |  |  |--[-] IPv4 ACL Logging
|  |  |  |  |  |--[-] IPv4 ACL MIB
|  |  |  |  |  |--[-] IPv4 ACL Object Groups (Scale)
|  |  |  |  |  |--[-] IPv4 ACL Police
|  |  |  |  |  |--[-] IPv4 ACL Priority
|  |  |  |  |  |--[*] IPv4 ACL Protocol Range
|  |  |  |  |  |--[-] IPv4 ACL Set TTL
|  |  |  |  |  |--[-] IPv4 ACL TCP Flags
|  |  |  |  |  |--[-] IPv4 ACL TTL
|  |  |  |  |  |--[-] IPv4 ACL UDF
|  |  |  |  |--[-] IPv4 Prefix-List
|  |  |  |  |--[-] IPv6 Prefix-List
```

View the List of Supported ACL Features

In this example, the capabilities for ACL features on the router are displayed.

```
Router#show features acl
Fri Sep 1 19:17:31.635 UTC
Key:
X - Unsupported
- - Supported
? - Support unknown (optional package not installed)
* - Support data not available

[-] Access Control List (ACL)
|--[-]  IPv6 ACL Support
|  |--[*] IPv6 ACL ABF Track
|  |--[*] IPv6 ACL BNG
|  |--[*] IPv6 ACL Chaining (Meta ACL)
|  |--[-] IPv6 ACL Common ACL
|  |--[-] IPv6 ACL Compression
|  |--[*] IPv6 ACL Default ABF
|  |--[*] IPv6 ACL Fragment
|  |--[-] IPv6 ACL ICMP Off
```

```
|   |--[-] IPv6 ACL ICMP Protocol
|   |--[-] IPv6 ACL Interface Statistics
|   |--[-] IPv6 ACL Log Rate
|   |--[-] IPv6 ACL Log Threshold
|   |--[-] IPv6 ACL Logging
|   |--[-] IPv6 ACL MIB
|   |--[-] IPv6 ACL Object Groups (Scale)
|   |--[-] IPv6 ACL Police
|   |--[-] IPv6 ACL Priority
|   |--[*] IPv6 ACL Protocol Range
|   |--[-] IPv6 ACL Set Qos-Group
|   |--[-] IPv6 ACL Set TTL
|   |--[-] IPv6 ACL TCP Flags
|   |--[-] IPv6 ACL TTL Match
|   |--[-] IPv6 ACL UDF
|--[-] ES-ACL Support (L2 ACL)
|--[-] IPv4 ACL Support
|   |--[-] IPv4 ACL  Set Qos-group
|   |--[*] IPv4 ACL ABF Track
|   |--[*] IPv4 ACL BNG
|   |--[*] IPv4 ACL Chaining (Meta ACL)
|   |--[-] IPv4 ACL Common ACL
|   |--[-] IPv4 ACL Compression
|   |--[*] IPv4 ACL Default ABF
|   |--[*] IPv4 ACL Fragment
|   |--[-] IPv4 ACL Fragment Flags
|   |--[-] IPv4 ACL ICMP Off
|   |--[-] IPv4 ACL ICMP Protocol
|   |--[-] IPv4 ACL Interface Statistics
|   |--[-] IPv4 ACL Log Rate
|   |--[-] IPv4 ACL Log Threshold
|   |--[-] IPv4 ACL Logging
|   |--[-] IPv4 ACL MIB
|   |--[-] IPv4 ACL Object Groups (Scale)
|   |--[-] IPv4 ACL Police
|   |--[-] IPv4 ACL Priority
|   |--[*] IPv4 ACL Protocol Range
|   |--[-] IPv4 ACL Set TTL
|   |--[-] IPv4 ACL TCP Flags
|   |--[-] IPv4 ACL TTL
|   |--[-] IPv4 ACL UDF
|--[-] IPv4 Prefix-List
|--[-] IPv6 Prefix-List
```

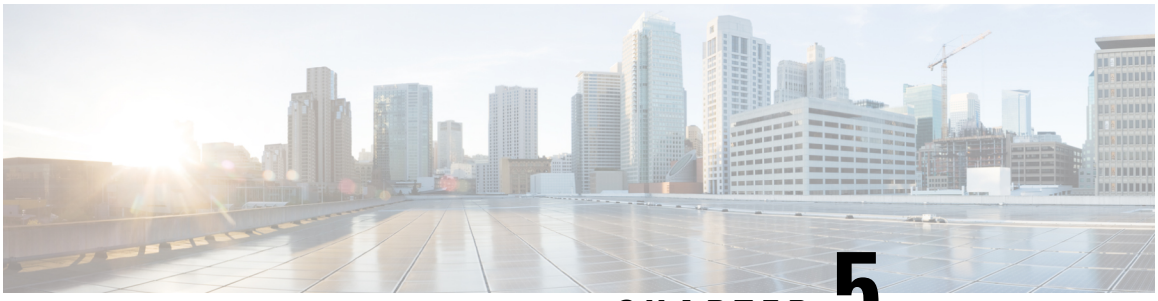
View the List of Supported ACL Features for Specific RP

In this example, the capabilities for ACL features on the RP location `0/RP0/CPU0` are displayed.

```
Router#show features acl detail location 0/RP0/CPU0
Fri Sep 1 19:15:49.889 UTC
Key:
X - Unsupported
- - Supported
? - Support unknown (optional package not installed)
* - Support data not available

[-] Access Control List (ACL)
    Cisco provides basic traffic filtering capabilities with access control
    lists (also referred to as access lists). User can configure access
    control lists (ACLs) for all routed network protocols to filter protocol
    packets when these packets pass through a device. User can configure
    access lists on your device to control access to a network, access lists
```

```
    can prevent certain traffic from entering or exiting a network.
|--[-]  IPv6 ACL Support
|       IPv6 based ACL is a list of source IPv6 addresses that use Layer 3 or
|       Layer 4 information to permit or deny access to traffic. IPv6 router
|       ACLs apply only to IPv6 packets that are routed.. A filter contains the
|       rules to match the packet matches, the rule also stipulates if the
|       packet should be permitted or denied.
|   |--[*] IPv6 ACL ABF Track
|   |      IPv6 ACL ABF Track allows the user to configure a rule with track as
|   |      nexthop inside the ACL rule . ACL Based Forwarding (ABF) denotes the
|   |      ability to forward packets to another next hop router based on the
|   |      criteria defined in the rule. Track takes precedence over VRF and
|   |      IP, if present in the nexthop
|   |--[*] IPv6 ACL BNG
|   |      IPv6 ACL BNG is an ACL subscriber BNG feature. It allows the use of
|   |      ACL on dynamic template.
|   |--[*] IPv6 ACL Chaining (Meta ACL)
|   |      IPv6 ACL Chaining (Meta ACL) allows the user to apply more than one
|   |      ACL on the interface.  is known as Meta ACL or ACL chaining.
|   |--[-] IPv6 ACL Common ACL
|   |      IPv6 ACL Common allows the user to apply the ACL on the interface
|   |      using the common keyword. Using this feature the ACL won't be
|   |      applied to the specific interface but it will be common to th entire
|   |      NPU to which the interface belongs.
|   |--[-] IPv6 ACL Compression
|   |      IPv6 ACL Compression allows the user to apply the ACL on the
|   |      interface using a compression level. This helps in reducing the
|   |      hardware resources needed to program the ACL.
|   |--[*] IPv6 ACL Default ABF
|   |      IPv6 ACL Default ABF allows the user to configure a rule with
|   |      default nexthop inside the ACL rule . ACL Based Forwarding (ABF)
|   |      denotes the ability to forward packets to another next hop router
|   |      based on the criteria defined in the rule
|   |--[*] IPv6 ACL Fragment
|   |      IPv6 ACL Fragment allows the user to configure a rule with fragment
|   |      inside the ACL rule and use it as a match criteria to filter traffic.
|   |--[-] IPv6 ACL ICMP Off
|   |      IPv6 ACL ICMP Off allows the user to not genearte the ICMP error
|   |      message on a deny action. When configured it will not send the
|   |      packet to FIB to generate ICMP error message.
------------------------- Truncated for Brevity -------------------------
```



CHAPTER 5

Deploy Router Using Secure ZTP

With Secure Zero Touch Provisioning (ZTP), you can securely and seamlessly provision thousands of network devices accurately within minutes and without any manual intervention.

Table 9: Feature History Table

Feature	Release Information	Feature Description
Secure Zero Touch Provisioning with Removable Storage Device	Release 7.3.2	This feature allows you to securely sign onboarding data in a removable storage device so that you can use the device for secure ZTP operations. This support gives you the plug-and-play flexibility for ZTP without any additional infrastructure requirements.
Secure Zero Touch Provisioning	Release 7.3.1	This feature allows devices in the network to establish a secure connection with the ZTP server and authenticate information using a three-step validation process involving validation of the network device, the ZTP server, and onboarding information. This eliminates security risks or malicious actions during remote provisioning. The **ztp secure-mode enable** command is introduced.

In a secured network such as datacenter, the zero-touch provisioning mechanism helps you provision hundreds of remote devices without your intervention. But, the access devices are typically in an insecure network. There is a high risk of malicious actions on the device, such as adding an unauthorized or infected device. Security is a critical aspect while remotely provisioning the network devices.

Secure ZTP combines seamless automation with security. Network devices can securely establish a connection with the ZTP server and authenticate the onboarding information that it receives. The process eliminates any security risks or malicious actions during the provisioning of remote devices.

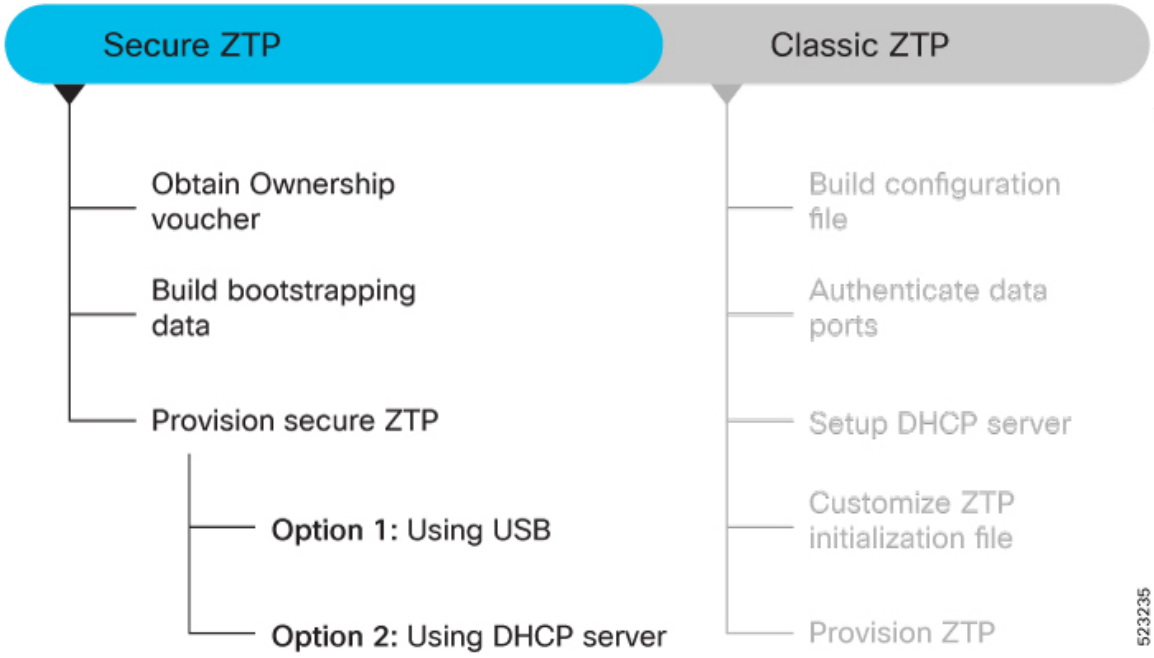
- ZTP helps you remotely provision a router securely anywhere in the network. Thus, eliminate the risk of malicious attacks or unauthorized ownership claims.
- Secure ZTP authenticates not only the onboarding network device but also validates the server authenticity and provisioning information that it is receiving from the ZTP server.

Cisco IOS XR software implements the secure zero touch provisioning capabilities as described in RFC 8572. Secure ZTP uses a three-step validation process to onboard the remote devices securely:

1. Router Validation: The ZTP server authenticates the router before providing bootstrapping data using the Trust Anchor Certificate (also called SUDI certificate).
2. Server Validation: The router device in turn validates the ZTP server to make sure that the onboarding happens to the correct network. Upon completion, the ZTP server sends the bootstrapping data (for example, a YANG data model) or artifact to the router.
3. Artifact Validation: The configuration validates the bootstrapping data or artifact received from the ZTP server.

Follow the workflow to understand the tasks involved in provisioning the router using secure ZTP.

Figure 12: Secure ZTP Workflow



This section contains the following topics:

- Obtain Ownership Voucher, on page 59
- Build Bootstrapping Data, on page 59
- Secure ZTP Options, on page 62

Obtain Ownership Voucher

Ownership Voucher is used to identify the owner of the device by verifying the owner certificate that is stored in the device. Cisco supplies Ownership Voucher in response to your request. You must submit the Pinned Domain Certificate and device serial numbers with the request. Cisco generates and provides the Ownership Voucher to you.

Contact Cisco Support to obtain a voucher. Provide the following details to request for ownership voucher certificate:

- Pinned Domain certificate (PDC): PDC is an X.509 v3 certificate structure that uses Distinguished Encoding Rules (DER). This certificate is used by the router to trust a public key infrastructure in order to verify a domain certificate supplied to the router separately in the bootstrapping data. This certificate could be an end-entity certificate, including a self signed entity.
- Order details with the Serial numbers of the routers

For example,

```
{
       "expires-on": "2016-10-21T19:31:42Z",
       "assertion": "verified",
       "serial-number": "JADA123456789",
       "idevid-issuer": "base64encodedvalue==",
       "pinned-domain-cert": "base64endvalue==",
       "last-renewal-date": "2017-10-07T19:31:42Z"
   }
```

Based on the details that you provide, Cisco generates the ownership voucher in .vcj format. For example, DCA213140YX.vcj.

Build Bootstrapping Data

The following describe the components of secure ZTP:

- **Onboarding Device (Router):** The router is a Cisco device that you want to provision and connect to your network. Secure ZTP is supported only on platforms that have Hardware TAM support. Routers with HW TAM have the SUDI embedded in TAM.
- **DHCP Server:** The secure ZTP process relies on the DHCP server to provide the URL to access the bootstrapping information.
- **ZTP Server:** A ZTP server is any server used as a source of secure ZTP bootstrapping data and can be a RESTCONF or HTTPs server.

Note ZTP only supports single name-server. When the DHCP server has more than one server address configured, ZTP fails to apply the server configuration.

The ZTP server contains the following artifacts:

- Cisco IOS XR software images: You can download Cisco images, SMU, and patches using the Cisco Support & Downloads page.

- ZTP scripts: Contains the following libraries and you can build a script to initiate the ZTP process.
  - Python library: Includes IOS XR CLI (show commands and configuration commands), YANG-XML (ncclient, native Netconf client), and YANG-JSON (gnmic or gNMI client)).
  - BASH library: Includes IOS XR CLI show commands, configuration commands
- Bootstrapping Data

- **Bootstrapping Data:** It is the collection of data that the router obtains from the ZTP server during the secure ZTP process. You must create and upload the bootstrapping data in the ZTP server. For more information, refer RFC 8572.
  - The bootstrapping data mainly has three artifacts:
    - **Conveyed Information**: Conveyed Information contains the required bootstrapping data for the device. It contains either the redirect information or onboarding information to provision the device.

      For example:

```
module: ietf-sztp-conveyed-info

          yang-data conveyed-information:
            +-- (information-type)
               +--:(redirect-information)
               |  +-- redirect-information
               |     +-- bootstrap-server* [address]
               |        +-- address         inet:host
               |        +-- port?           inet:port-number
               |        +-- trust-anchor?   cms
               +--:(onboarding-information)
                  +-- onboarding-information
                     +-- boot-image
                     |  +-- os-name?              string
                     |  +-- os-version?           string
                     |  +-- download-uri*         inet:uri
                     |  +-- image-verification* [hash-algorithm]
                     |     +-- hash-algorithm    identityref
                     |     +-- hash-value        yang:hex-string
                     +-- configuration-handling?      enumeration
                     +-- pre-configuration-script?    script
                     +-- configuration?               binary
                     +-- post-configuration-script?   script
```

    - **Redirect Information**: Redirect information is used to redirect a device to another bootstrap server. The redirect information contains a list of bootstrap servers along with a hostname, an optional port, and an optional trust anchor certificate that the device uses to authenticate the bootstrap server.

      For Example:

```
{
     "ietf-sztp-conveyed-info:redirect-information" : {
       "bootstrap-server" : [
         {
           "address" : "sztp1.example.com",
           "port" : 8443,
            "trust-anchor" : "base64encodedvalue=="
         },
         {
```

```
            "address" : "sztp2.example.com",
            "port" : 8443,
            "trust-anchor" : "base64encodedvalue=="
          },
          {
            "address" : "sztp3.example.com",
            "port" : 8443,
            "trust-anchor" : "base64encodedvalue=="
          }
        ]
      }
    }
```

- **Onboarding Information:** Onboarding information provides data necessary for a device to bootstrap itself and establish secure connections with other systems. It specifies details about the boot image, an initial configuration the device must commit, and scripts that the device must execute.

  For Example:

```
{
     "ietf-sztp-conveyed-info:onboarding-information" : {
       "boot-image" : {
         "os-name" : "VendorOS",
         "os-version" : "17.2R1.6",
         "download-uri" : [ "https://example.com/path/to/image/file" ],
         "image-verification" : [
           {
             "hash-algorithm" : "ietf-sztp-conveyed-info:sha-256",
             "hash-value" : "ba:ec:cf:a5:67:82:b4:10:77:c6:67:a6:22:ab:\
   7d:50:04:a7:8b:8f:0e:db:02:8b:f4:75:55:fb:c1:13:b2:33"
           }
         ]
       },
       "configuration-handling" : "merge",
       "pre-configuration-script" : "base64encodedvalue==",
       "configuration" : "base64encodedvalue==",
       "post-configuration-script" : "base64encodedvalue=="
     }
   }
```

  - **Owner Certificate**: The owner certificate is installed on the router with the public key of your organization. The router uses the owner certificate to verify the signature in the conveyed information artifact using the public key that is available in the owner certificate.
  - **Ownership Voucher**: Ownership Voucher is used to identify the owner of the device by verifying the owner certificate that is stored in the device. Cisco supplies Ownership Voucher in response to your request. You must submit the Pinned Domain Certificate and device serial numbers with the request. Cisco generates and provides the Ownership Voucher to you.

- **Report Progress:** When the device obtains the onboarding information from a ZTP server, the router reports the bootstrapping progress to the ZTP server using the API calls.

  See RFC 8572 for the detailed report-progress messages that can be sent to the ZTP server.

  The following is the structure of the `report-progress` sent the progress message to a ZTP server.

```
+---x report-progress {onboarding-server}?
         +---w input
```

```
+---w progress-type         enumeration
+---w message?              string
+---w ssh-host-keys
|  +---w ssh-host-key* []
|     +---w algorithm    string
|     +---w key-data     binary
+---w trust-anchor-certs
   +---w trust-anchor-cert*   cms
```

The following example illustrates a device using the Yang module to post a progress report to a ZTP server with a `bootstrap complete` message:

```
{
        'progress-type': 'bootstrap-complete',
        'message': 'example message',
        'trust-anchor-certs': [{
                'trust-anchor-cert': 'base64encodedvalue=='
        'ssh-host-keys': [{
                'key-data': 'base64encodedvalue==',
                'algorithm': 'ssh-rsa'
        }, {
                'key-data': 'base64encodedvalue==',
                'algorithm': 'rsa-sha2-256'
        }]
}
```

```
RESPONSE from the ZTP server

   HTTP/1.1 204 No Content
   Date: Sat, 31 Oct 2015 17:02:40 GMT
   Server: example-server
```

Secure ZTP Options

Provision Secure ZTP Using USB

A Removable storage device such as a USB drive is an untrusted source of bootstrapping data. So, the onboarding information present in the removable storage device must always be signed.

Whenever the data is signed, it's mandatory that the Owner Certificate and Ownership Voucher must also be available. The removable storage device must contain the following three artifacts. For more information on the three artifacts, see Build Bootstrapping Data, on page 59.

- Conveyed Information
- Owner Certificate
- Ownership Voucher

The network administrator performs the following tasks as part of the initial setup for secure ZTP:

Before you begin

The network administrator performs the following tasks as part of the initial setup for secure ZTP:

- Ensure to enable secure ZTP on the router using the **ztp secure-mode enable** command and then reload the router.

- Contact Cisco Support to obtain a voucher. Provide the following details to request for ownership voucher certificate:
  - Pinned Domain certificate (PDC): PDC is an X.509 v3 certificate structure that uses Distinguished Encoding Rules (DER). This certificate is used by the router to trust a public key infrastructure in order to verify a domain certificate supplied to the router separately in the bootstrapping data. This certificate could be an end-entity certificate, including a self signed entity.
  - Order details with the Serial numbers of the routers

  For example,

```
{
        "expires-on": "2016-10-21T19:31:42Z",
        "assertion": "verified",
        "serial-number": "JADA123456789",
        "idevid-issuer": "base64encodedvalue==",
        "pinned-domain-cert": "base64endvalue==",
        "last-renewal-date": "2017-10-07T19:31:42Z"
    }
```

Step 1 Copy the following data to the removable storage device in the **EN9** directory in its root:

- Conveyed information: Conveyed information: Conveyed information must be named as `conveyed-information.cms` and must contain only the onboarding information and not the redirect information. The conveyed information consists of the following onboarding information:
  - Cisco IOS XR software images: You can download Cisco images, SMU, and patches using the Cisco Support & Downloads page.
  - ZTP scripts that include IOS XR configurations, pre, and post configuration scripts. During the secure ZTP process, secure ZTP executes the scripts to provision the router. You can build your script using one of the following methods:
    - Python library: Includes IOS XR CLI (show commands and configuration commands) and YANG-XML (`ncclient`, `native Netconf client`).
    - BASH library: Includes IOS XR CLI show commands, configuration commands.
- Owner certificate: The owner certificate must be named as `owner-certificate.cms`.
- Ownership vouchers: The ownership vouchers must be named as `ownership-voucher.vcj`.

Step 2 Plug in the removable storage device into the router.

Step 3 Power ON the router.

Here is the high-level workflow of the Secure ZTP process using a removable storage device:

a. When you boot the device with an IOS-XR image, the secure ZTP process verifies if the secure ZTP mode (`secure-ztp mode`) is enabled. If not enabled, the device boots normally.

b. The device verifies if the USB is enabled in the `ztp.ini` file. By default, the USB is enabled and assigned the highest priority in the fetcher priority in the `ztp.ini` file.

Fetcher priority defines how secure ZTP can get the provisioning details. By default, each port has a fetcher priority defined in the `ztp.ini` file. The fetcher priority range is from 0 to 9. The lower the number higher is the priority. The value 0 has the highest priority and 9 has the lowest priority.

The following example shows the sample of the `ztp.ini` file:

```
[Startup]
start: True
retry_forever: True

[Fetcher Priority]
USB: 0

Mgmt4:  1
Mgmt6:  2
DPort4: 3
DPort6: 4
```

c. Secure ZTP checks for a removable storage device on the router. If the removable storage device isn't available, the secure ZTP process moves to the next fetcher as defined in the fetcher priority of the `ztp.ini`file.

d. If a removable storage device is available, the router scans for the `EN9` directory in the root of the removable storage device.

If the `EN9` directory isn't available, the secure ZTP process moves to the next fetcher as defined in the fetcher priority of the `ztp.ini`file.

e. **Artifact Validation**:

The router validates the artifacts received from the removable storage device.

1. The router validates the ownership voucher and extracts the `pinned-domain-cert` node, an X.509 certificate from the ownership voucher to verify the owner certificate.
2. The router authenticates the owner certificate by performing the X.509 certificate path verification process on the trusted certificate.
3. Finally, the router verifies whether the conveyed information artifact is signed by the validated owner certificate.

f. **Provision the router**:

1. The device first processes the boot image information.
2. Executes the preconfiguration script and then commits the initial configuration.
3. Execute the post configuration script.

g. After the onboarding process is completed, router is operational.

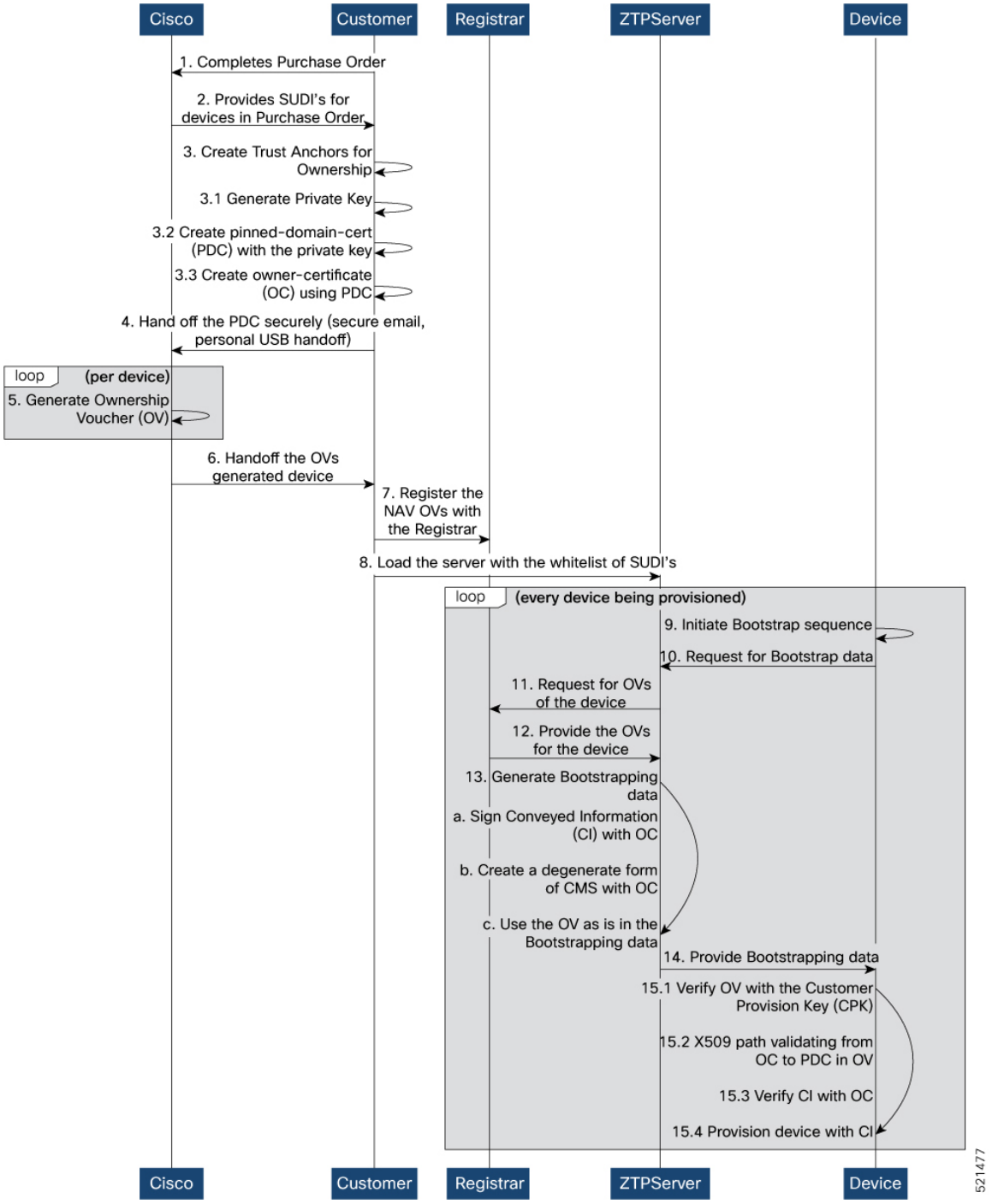
Note If there is a failure in any of the steps, the secure ZTP process moves to the next fetcher as defined in the fetcher priority of the `ztp.ini` file.

Provision Secure ZTP Using DHCP Server

When you boot the device, the ZTP process initiates automatically if the device does not have a prior configuration. During the process, the router receives the details of the configuration file from the DHCP server.

The following figure illustrates the end-to-end sequence of the Secure ZTP process:

Figure 13: End-to-end sequence of the Secure ZTP process



Before you begin

The network administrator performs the following tasks as part of the initial setup for secure ZTP:

- Ensure to enable secure ZTP on the router using the **ztp secure-mode enable** command and then reload the router.
- Contact Cisco Support to obtain a voucher. Provide the following details to request for ownership voucher certificate:
  - Pinned Domain certificate (PDC): PDC is an X.509 v3 certificate structure that uses Distinguished Encoding Rules (DER). This certificate is used by the router to trust a public key infrastructure in order to verify a domain certificate supplied to the router separately in the bootstrapping data. This certificate could be an end-entity certificate, including a self signed entity.
  - Order details with the Serial numbers of the routers

  For example,

```
{
        "expires-on": "2016-10-21T19:31:42Z",
        "assertion": "verified",
        "serial-number": "JADA123456789",
        "idevid-issuer": "base64encodedvalue==",
        "pinned-domain-cert": "base64endvalue==",
        "last-renewal-date": "2017-10-07T19:31:42Z"
    }
```

Step 1 Upload the following bootstrapping data to the ZTP server. Steps to upload may vary depending on the server that you're using, refer to the documentation provided by your vendor.

- Cisco IOS XR software images: You can download Cisco images, SMU, and patches using the Cisco Support & Downloads page.
- ZTP scripts that include IOS XR configurations, pre, and post configuration scripts. Build a script to initiate the ZTP process. See Build Configuration File, on page 72.
  - Python library: Includes IOS XR CLI (show commands and configuration commands) and YANG-XML (`ncclient`, `native Netconf client`).
  - BASH library: Includes IOS XR CLI show commands, configuration commands
- Serial numbers of the routers you plan to onboard using ZTP
- Owner certificates
- Pinned Domain Certificate (PDC)
- Ownership vouchers

Step 2 Set up the DHCP server to provide the redirect URL to the router:

Before triggering the secure ZTP process, configure the DHCP server to provide the location of the IOS-XR image to the router. For information on how to configure the DHCP server, see your DHCP server documentation.

Configure the following parameters in the DHCP server:

- `option-code`: The DHCP SZTP redirect Option has the following parameters:
  - OPTION_V4_SZTP_REDIRECT (143): Use this DHCP v4 code for IPV4.
  - OPTION_V6_SZTP_REDIRECT (136): Use this DHCP v4 code for IPV6.

For example, `option dhcp6.bootstrap-servers code 136 = text;`

- `option-length`: The option length in octets
- `bootstrap-servers`: A list of servers for the onboarding device to contact the servers for the bootstrapping data.
- `bootfile-url` : The URI of the SZTP bootstrap server should use the HTTPS URI scheme and it should be in the following format:

  `"https://<ip-address-or-hostname>[:<port>]".`

Step 3 Power on the router.

Here is the high-level workflow of the Secure ZTP process using a removable storage device:

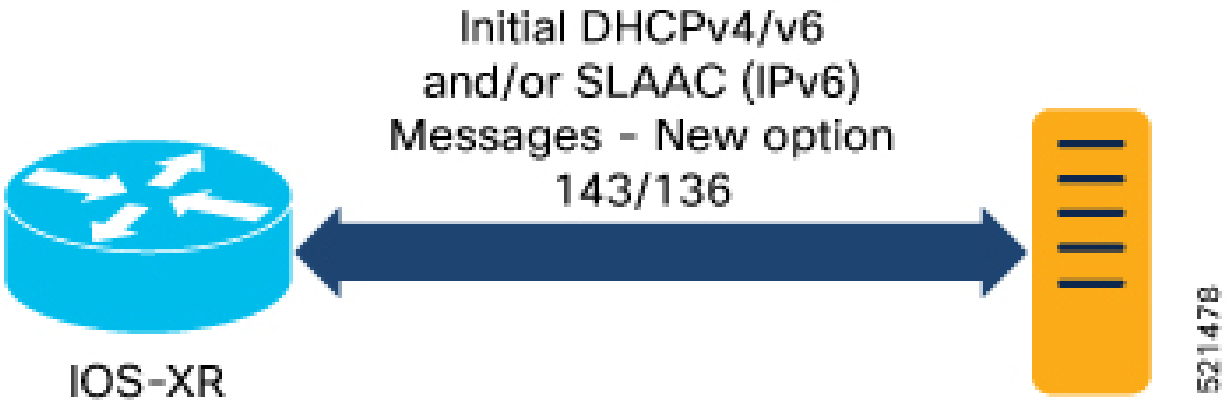
a. When you boot the device with an IOS-XR image, the secure ZTP process verifies if the secure ZTP mode (`secure-ztp mode`) is enabled. If not enabled, the device boots normally.

Note When `secure-ztp mode` is enabled, the ZTP process accepts only the `secure-redirect-URL` and ignores the presence of boot file name option from the DHCP response.

b. **DHCP discovery**:

1. The router initiates a DHCP request to the DHCP server.
2. The DHCP server responds with a DHCPv4 143 address option (for IPv4 addressing) or a DHCPv6 136 option (for IPv6 addressing). In addition, URLs to access bootstrap servers for further configuration is also listed.

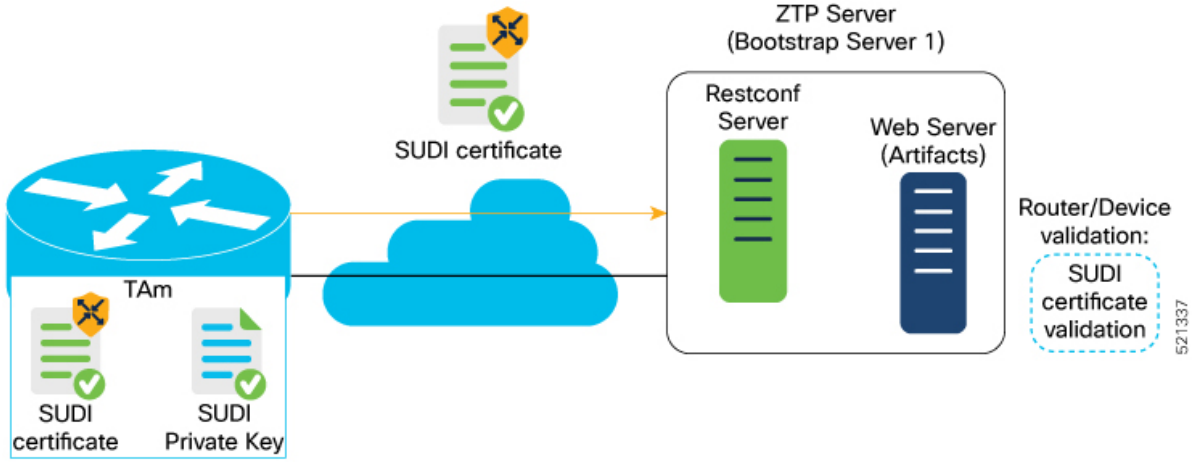
Figure 14: DHCP discovery



c. **Router validation**:

1. After receiving the URL from the DHCP server, the router sends an HTTPs request to the RESTCONF or HTTPs server using the specified URL. Along with the HTTPs request, the device sends the client certificate that is provided by the manufacturer (also called SUDI certificate). This certificate identifies and authenticates itself to the ZTP server.

Figure 15: Router Validation for Secure ZTP Provisioning

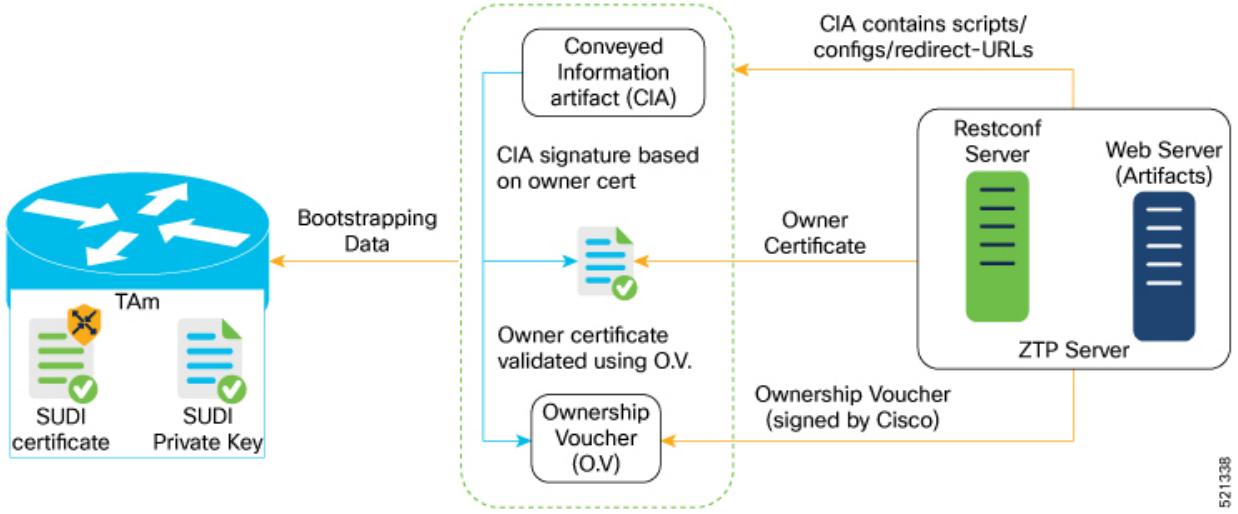


2. The RESTCONF or HTTPs server verifies the received SUDI certificate with the public certificate that it contains. Cisco issues the public certificate to ensure that the onboarding device is an authorized Cisco device.
3. After the onboarding device is authenticated, the web server sends the required artifacts along with the secure ZTP yang model to the onboarding device.

d. Server validation :

The router receives the yang model that contains Owner Certificate, Ownership Voucher, and Conveyed Information artifact. The router verifies the ownership voucher by validating its signature to one of its preconfigured trusts anchors and downloads the image. When the router obtains the onboarding information, it reports the bootstrapping progress to the ZTP server. See RFC 8572 for the progress information.

Figure 16: Server Validation for Secure ZTP Provisioning



e. Artifact Validation:

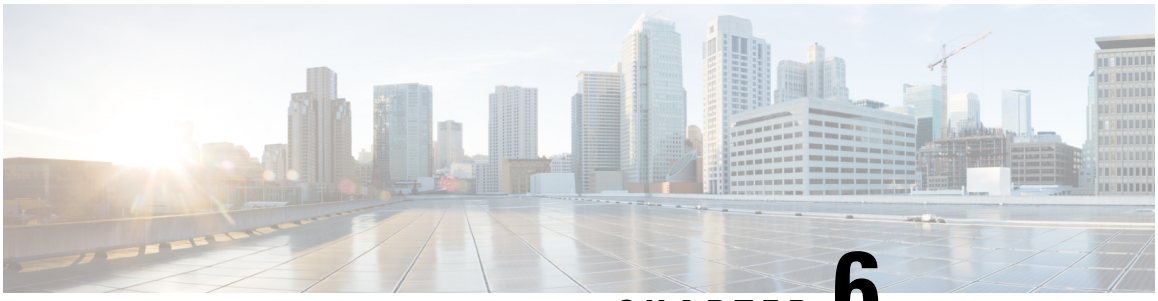
The router validates the artifact received from the ZTP server.

1. The device extracts the `pinned-domain-cert` node, an X.509 certificate from the ownership voucher to verify the owner certificate.
2. The device authenticates the owner certificate by performing the X.509 certificate path verification process on the trusted certificate.
3. Finally, the device verifies whether the conveyed information artifact is signed by the validated owner certificate.

f. **Provision the device**:

1. The device first processes the boot image information.
2. Executes the pre-configuration script and then commits the initial configuration
3. Execute the post configuration script.

g. After the onboarding process is completed, the network device is operational.



CHAPTER 6

Deploy Router Using Classic ZTP

Manually deploying network devices in a large-scale environment requires skilled workers and is time consuming.

With Zero Touch Provisioning (ZTP), you can seamlessly provision thousands of network devices accurately within minutes and without any manual intervention. This can be easily defined using a configuration file or script using shell or phyton. Currently, ZTP only supports single name-server. When the DHCP server has more than one server address configured, ZTP fails to apply the server configuration.

ZTP provides multiple options, such as:

- Automatically apply specific configuration in a large-scale environment.
- Download and install specific IOS XR image.
- Install specific application package or third party applications automatically.
- Deploy containers without manual intervention.
- Upgrade or downgrade software versions effortlessly on thousands of network devices at a time

Benefits of Using ZTP

ZTP helps you manage large-scale service providers infrastructures effortlessly. Following are the added benefits of using ZTP:

- ZTP helps you to remotely provision a router anywhere in the network. Thus eliminates the need to send an expert to deploy network devices and reduces IT cost.
- Automated provisioning using ZTP can remove delay and increase accuracy and thus is cost-effective and provides better customer experience.

  By automating repeated tasks, ZTP allows network administrators to concentrate on more important stuff.
- ZTP process helps you to quickly restore service. Rather than troubleshooting an issue by hand, you can reset a system to well-known working status.

Use Cases

The following are some of the useful use cases for ZTP:

- Using ZTP to install Chef

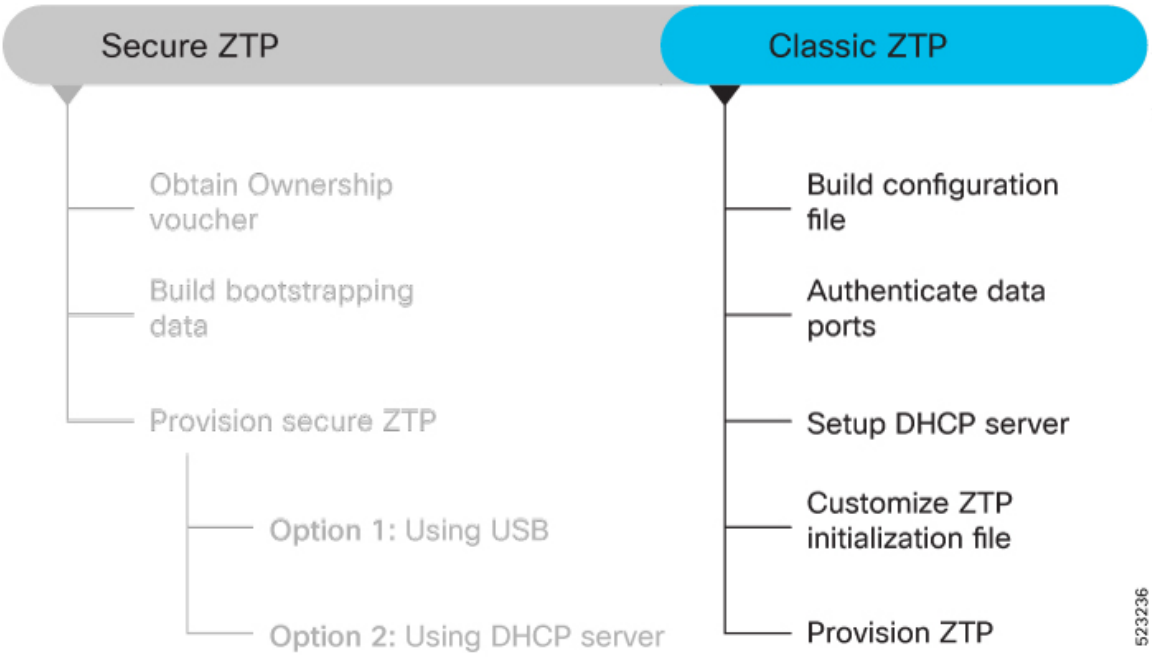
- Using ZTP to integrate IOS-XR with NSO
- Using ZTP to install Puppet

You can initiate ZTP in one of the following ways:

- **Fresh Boot**: Use this method for devices that has no pre-loaded configuration. See Getting Started with ZTP on a Fresh Boot of a Router.
- **Manual Invocation:** Use this method when you want to forcefully initiate ZTP on a fully configured device.
- **ZTP Bootscript**: Use this method when you want to hard code a script to be executed on every boot.

Follow the workflow to understand the tasks involved in provisioning the router using classic ZTP.

Figure 17: Classic ZTP Workflow



This section contains the following topics:

Build Configuration File

Based on the business need, you can use a configuration or script file to initiate the ZTP process.

Attention When you use a USB flash drive as a source for ZTP, you cannot use the script file for provisioning. The script file is not supported in the USB fetcher. Fetcher defines which port the ZTP process should use to get the provisioning details as defined in the `ztp.ini` file.

The configuration file content starts with *!! IOS XR* and the script file content starts with *#! /bin/bash, #! /bin/sh or #!/usr/bin/python.*

Once you create the configuration file, apply it to the device using the *ztp_helper* function *xrapply*.

Note We recommend that you don't execute the APIs on a router that is already provisioned. ZTP Utility APIs are designed to be executed from the ZTP script when you boot the router for the first time. The APIs perform additional operations to run the requested actions during the boot process and bring changes in the existing configuration before executing any action.

ZTP utility APIs have prerequisites which are executed in the ZTP workflow before running the ZTP utility APIs. These prerequisites help with running specific actions during the boot process and in making necessary configuration changes.

We recommend that you don't use ZTP utilities outside the scope of ZTP script. The APIs in this script use username as `ztp` or `ztp-user` in every action. The ZTP utility executed outside the scope of the ZTP script may fail as it's not executed from the ZTP workflow. This may modify the configurations on the device and affect other related operations. If the ZTP utility is executed outside the scope ZTP script, the logs display that the script is executed using username `ztp` or `ztp-user`, misleading that the script is executed from the workflow.

The following is the sample configuration file:

```
!! IOS XR
username root
group root-lr
password 0 lablab
!

hostname ios
alias exec al show alarms brief system active

interface HundredGigE 0/0/0/24
ipv4 address 10.10.10.55 255.255.255.0
no shutdown
!
```

You can also use a script file to initiate the ZTP process. This script or binary is executed in the IOS XR bash shell and can be used to interact with IOS XR CLI to configure, verify the configured state and even run EXEC commands based on the workflow that you choose. Build your ZTP script with either shell and python. ZTP includes a set of CLI commands and a set of shell utilities that can be used within the user script. ZTP includes a set of shell utilities that can be sourced within the user script. The `ztp_helper.sh` is a shell script that can be sourced by the user script. This script provides simple utilities to access XR functionalities. For information on helper APIs, see the Github repository.

The following shows the sample script in python.

```
[apple2:~]$ python sample_ztp_script.py
###### Debugs enabled ######
```

```
###### Change context to user specified VRF ######

###### Using Child class method, setting the root user ######
2016-12-17 04:23:24,091 - DebugZTPLogger - DEBUG - Config File content to be applied !
                username netops
                group root-lr
                group cisco-support
                secret 5 $1$7kTu$zjrgqbgW08vEXsYzUycXw1
                !
                end
2016-12-17 04:23:28,546 - DebugZTPLogger - DEBUG - Received exec command request: "show
configuration commit changes last 1"
2016-12-17 04:23:28,546 - DebugZTPLogger - DEBUG - Response to any expected prompt ""
Building configuration...
2016-12-17 04:23:29,329 - DebugZTPLogger - DEBUG - Exec command output is ['!! IOS XR
Configuration version = 6.2.1.21I', 'username netops', 'group root-lr', 'group cisco-support',

   'secret 5 $1$7kTu$zjrgqbgW08vEXsYzUycXw1', '!', 'end']
2016-12-17 04:23:29,330 - DebugZTPLogger - DEBUG - Config apply through file successful,
last change = ['!! IOS XR Configuration version = 6.2.1.21I', 'username netops', 'group
root-lr', 'group cisco-support', 'secret 5 $1$7kTu$zjrgqbgW08vEXsYzUycXw1', '!', 'end']

###### Debugs Disabled ######

###### Executing a show command ######
Building configuration...
{'output': ['!! IOS XR Configuration version = 6.2.1.21I',
        '!! Last configuration change at Sat Dec 17 04:23:25 2016 by UNKNOWN',
        '!',
        'hostname customer2',
        'username root',
        'group root-lr',
        'group cisco-support',
        'secret 5 $1$7kTu$zjrgqbgW08vEXsYzUycXw1',
        '!',
        'username noc',
        'group root-lr',
        'group cisco-support',
        'secret 5 $1$7kTu$zjrgqbgW08vEXsYzUycXw1',
        '!',
        'username netops',
        'group root-lr',
        'group cisco-support',
        'secret 5 $1$7kTu$zjrgqbgW08vEXsYzUycXw1',
        '!',
        'username netops2',
        'group root-lr',
        'group cisco-support',
        'secret 5 $1$7kTu$zjrgqbgW08vEXsYzUycXw1',
        '!',
        'username netops3',
        'group root-lr',
        'group cisco-support',
        'secret 5 $1$7kTu$zjrgqbgW08vEXsYzUycXw1',
        '!',
        'cdp',
        'service cli interactive disable',
        'interface MgmtEth0/RP0/CPU0/0',
        'ipv4 address 11.11.11.59 255.255.255.0',
        '!',
        'interface TenGigE0/0/0/0/24',
        'shutdown',
        '!',
        'interface TenGigE0/0/0/0/25',
```

```
        'shutdown',
        '!',
        'router static',
        'address-family ipv4 unicast',
        '0.0.0.0/0 11.11.11.2',
        '!',
        '!',
        'end'],
        'status': 'success'}

###### Apply valid configuration using a file ######
Building configuration...
{'status': 'success', 'output': ['!! IOS XR Configuration version = 6.2.1.21I', 'hostname
customer', 'cdp', 'end']}

###### Apply valid configuration using a string ######
Building configuration...
{'output': ['!! IOS XR Configuration version = 6.2.1.21I',
        'hostname customer2',
        'end'],
'status': 'success'}

###### Apply invalid configuration using a string ######
{'output': ['!! SYNTAX/AUTHORIZATION ERRORS: This configuration failed due to',
        '!! one or more of the following reasons:',
        '!! - the entered commands do not exist,',
        '!! - the entered commands have errors in their syntax,',
        '!! - the software packages containing the commands are not active,',
```

The XML-encoded YANG configuration that follows shows various network settings including:

- Basic setup, including line configuration (TTY, VTY)
- User setup such as System Utilities
- Network configurations such as, domain service, Management IP address assignment, NETCONF, IP routing
- Protocol configurations such as, SSH, LLDP, gRPC
- Security (AAA)
- Interface settings (Interface (IF) manager)

```
Router# python ztp_XML_test.py
# netconf_client_ztp_lib - version 1.2 #
2021-02-22 13:53:11,587 - DebugZTPLogger - DEBUG - netconf init attempt: 1
Building configuration...
2021-02-22 13:53:18,117 - DebugZTPLogger - DEBUG - Netconf yang agent is up
###################### Netconf response: Current running configuration ######################
<?xml version="1.0"?>
<rpc-reply message-id="101" xmlns="urn:ietf:params:xml:ns:netconf:base:1.0">
 <data>
  <netconf xmlns=http://cisco.com/ns/yang/Cisco-IOS-XR-man-xml-ttyagent-cfg>
   /* Enables NETCONF agent over TTY*/
   <agent>
    <tty>
     <enable></enable>
    </tty>
   </agent>
  </netconf>
<lldp xmlns=http://cisco.com/ns/yang/Cisco-IOS-XR-ethernet-lldp-cfg>
 /*Enables and configures global LLDP subcommands*/
  <enable>true</enable>
```

```
</lldp>
 <ip-domain xmlns=http://cisco.com/ns/yang/Cisco-IOS-XR-ip-domain-cfg>
  /*Configures domain service related commands*/
  <vrfs>
   <vrf>
    <vrf-name>default</vrf-name>
    <name>cisco.lab</name>
    <servers>
     <server>
      <order>0</order>
      <server-address>5.38.4.246</server-address>
     </server>
    </servers>
   </vrf>
  </vrfs>
</ip-domain>
<interface-configurations xmlns=http://cisco.com/ns/yang/Cisco-IOS-XR-ifmgr-cfg>
 /*Configures Interfaces and controls their activation and deactivation*/
  <interface-configuration>
   <active>act</active>
   <interface-name>HundredGigE0/0/0/14</interface-name>
   <shutdown></shutdown>
  </interface-configuration>
  <interface-configuration>
   <active>act</active>
   <interface-name>MgmtEth0/RP0/CPU0/0</interface-name>
   <ipv4-network xmlns=http://cisco.com/ns/yang/Cisco-IOS-XR-ipv4-io-cfg>
    /*Configures IPv4 Interface input and output settings on the device*/
    <addresses>
     <primary>
      <address>5.38.9.29</address>
      <netmask>255.255.0.0</netmask>
     </primary>
    </addresses>
   </ipv4-network>
  </interface-configuration>
  <interface-configuration>
   <active>act</active>
   <interface-name>FourHundredGigE0/0/0/0</interface-name>
   <shutdown></shutdown>
  </interface-configuration>
</interface-configurations>
<netconf-yang xmlns=http://cisco.com/ns/yang/Cisco-IOS-XR-man-netconf-cfg>
 /*Configures Network Configuration Protocol (NETCONF) commands*/
  <agent>
   <ssh>
    <enable></enable>
   </ssh>
  </agent>
</netconf-yang>
<tty xmlns=http://cisco.com/ns/yang/Cisco-IOS-XR-tty-server-cfg>
  <tty-lines>
   <tty-line>
    <name>default</name>
    <exec>
     <timeout>
      <minutes>0</minutes>
      <seconds>0</seconds>
     </timeout>
    </exec>
    <general>
     <absolute-timeout>0</absolute-timeout>
    </general>
   </tty-line>
```

```
  </tty-lines>
</tty>
<host-names xmlns=http://cisco.com/ns/yang/Cisco-IOS-XR-shellutil-cfg>
 /*Configures various system utilities related to the shell environment
of the system such as Hostname, Time zone, Prompt, Environmental variable configurations.*/

  <host-name>SF-1</host-name>
</host-names>
<grpc xmlns=http://cisco.com/ns/yang/Cisco-IOS-XR-man-ems-cfg>
  <port>57400</port>
  <no-tls></no-tls>
  <enable></enable>
</grpc>
<aaa xmlns=http://cisco.com/ns/yang/Cisco-IOS-XR-aaa-lib-cfg>
 /*Configures AAA (Authentication, Authorization, and Accounting) settings on the device*/
  <usernames xmlns=http://cisco.com/ns/yang/Cisco-IOS-XR-aaa-locald-cfg>
   <username>
    <ordering-index>0</ordering-index>
    <name>cafyauto</name>
    <usergroup-under-usernames>
     <usergroup-under-username>
      <name>root-lr</name>
     </usergroup-under-username>
     <usergroup-under-username>
      <name>cisco-support</name>
     </usergroup-under-username>
    </usergroup-under-usernames>
    <secret>
     <type>type10</type>
     <secret10>$6$iY.Zo/7E7RIG5o/.$PH1YegMZiHsiRDTxKOjKQ0i8rd4n
s2vHMHEmQrsMQrrtNTlj/gcBEQRXj3WDR8bAv0rWzz3aGdElteshHYXXR1</secret10>
    </secret>
   </username>
  </usernames>
  <accountings>
   <accounting>
    <type>commands</type>
    <listname>default</listname>
    <type-xr>start-stop</type-xr>
    <method1>local</method1>
   </accounting>
  </accountings>
</aaa>
<ssh xmlns=http://cisco.com/ns/yang/Cisco-IOS-XR-crypto-ssh-cfg>
 /*Configures the Secure Shell (SSH) settings on a device such as Encryption, Authentication,
 Session Management*/
  <server>
   <timeout>120</timeout>
   <rate-limit>600</rate-limit>
   <session-limit>110</session-limit>
   <v2></v2>
   <vrf-table>
    <vrf>
     <vrf-name>default</vrf-name>
     <enable></enable>
    </vrf>
   </vrf-table>
   <netconf>830</netconf>
   <netconf-vrf-table>
    <vrf>
     <vrf-name>default</vrf-name>
     <enable></enable>
    </vrf>
   </netconf-vrf-table>
```

```
  </server>
</ssh>
<router-static xmlns=http://cisco.com/ns/yang/Cisco-IOS-XR-ip-static-cfg>
/*Configures static IP routing on network devices*/
  <default-vrf>
   <address-family>
    <vrfipv4>
     <vrf-unicast>
      <vrf-prefixes>
       <vrf-prefix>
        <prefix>0.0.0.0</prefix>
        <prefix-length>0</prefix-length>
        <vrf-route>
         <vrf-next-hop-table>
          <vrf-next-hop-next-hop-address>
           <next-hop-address>5.38.0.1</next-hop-address>
          </vrf-next-hop-next-hop-address>
         </vrf-next-hop-table>
        </vrf-route>
       </vrf-prefix>
      </vrf-prefixes>
     </vrf-unicast>
    </vrfipv4>
   </address-family>
  </default-vrf>
</router-static>
<vty xmlns=http://cisco.com/ns/yang/Cisco-IOS-XR-tty-vty-cfg>
/*Configures virtual terminal lines (VTY lines) to access a device through SSH or TTY
protocols remotely.*/
  <vty-pools>
   <vty-pool>
    <pool-name>cafyauto</pool-name>
    <first-vty>5</first-vty>
    <last-vty>99</last-vty>
    <line-template>cafyauto</line-template>
   </vty-pool>
  </vty-pools>
</vty>
<netconf-yang xmlns=http://cisco.com/ns/yang/Cisco-IOS-XR-um-netconf-yang-cfg>
/*Configures the Network Configuration Protocol (NETCONF) settings and Yet Another Next
Generation (YANG) data modelling.*/
  <agent>
   <ssh/>
  </agent>
</netconf-yang>
<vty-pool xmlns=http://cisco.com/ns/yang/Cisco-IOS-XR-um-vty-pool-cfg>
 /*Configures virtual terminal (VTY) lines on large number of network devices*/
  <pools>
   <pool>
    <pool-name>cafyauto</pool-name>
    <first-vty-number>5</first-vty-number>
    <last-vty-number>99</last-vty-number>
    <line-template>cafyauto</line-template>
   </pool>
  </pools>
</vty-pool>
<interfaces xmlns=http://cisco.com/ns/yang/Cisco-IOS-XR-um-interface-cfg>
 /*Configures Interface settings such as interface, security, and performance on a device*/

  <interface>
   <interface-name>HundredGigE0/0/0/14</interface-name>
   <shutdown/>
  </interface>
  <interface>
```

```
   <interface-name>MgmtEth0/RP0/CPU0/0</interface-name>
   <ipv4>
    <addresses xmlns=http://cisco.com/ns/yang/Cisco-IOS-XR-um-if-ip-address-cfg>
     /*Configures IP address settings on network interfaces of a device.*/
     <address>
      <address>5.38.9.29</address>
      <netmask>255.255.0.0</netmask>
     </address>
    </addresses>
   </ipv4>
  </interface>
</interfaces>
<lldp xmlns=http://cisco.com/ns/yang/Cisco-IOS-XR-um-lldp-cfg/>
/*Configures the Link Layer Discovery Protocol (LLDP) settings on a network device.*/
<domain xmlns=http://cisco.com/ns/yang/Cisco-IOS-XR-um-domain-cfg>
 /*Configures domain settings on the device*/
  <name>cisco.lab</name>
  <name-servers>
   <name-server>
    <order>0</order>
    <address>5.38.4.246</address>
   </name-server>
  </name-servers>
</domain>
<xr-xml xmlns=http://cisco.com/ns/yang/Cisco-IOS-XR-um-xml-agent-cfg>
/*Configures XML agent settings such as Data formatting, Network Management, and Secure
transport layers on the router.*/
  <agent>
   <ssl/>
   <tty/>
   <enable/>
  </agent>
</xr-xml>
<netconf xmlns=http://cisco.com/ns/yang/Cisco-IOS-XR-um-xml-agent-cfg>
  <agent>
   <tty/>
  </agent>
</netconf>
<router xmlns=http://cisco.com/ns/yang/Cisco-IOS-XR-um-router-static-cfg>
 /*Configures the static routing settings on network devices*/
  <static>
   <address-family>
    <ipv4>
     <unicast>
      <prefixes>
       <prefix>
        <prefix-address>0.0.0.0</prefix-address>
        <prefix-length>0</prefix-length>
        <nexthop-addresses>
         <nexthop-address>
          <address>5.38.0.1</address>
         </nexthop-address>
        </nexthop-addresses>
       </prefix>
      </prefixes>
     </unicast>
    </ipv4>
   </address-family>
  </static>
</router>
<ssh xmlns=http://cisco.com/ns/yang/Cisco-IOS-XR-um-ssh-cfg>
 /*Configures the Secure Shell (SSH) settings such as secure remote access,
Encryption, and security on a network device.*/
  <timeout>120</timeout>
```

```
  <server>
   <rate-limit>600</rate-limit>
   <session-limit>110</session-limit>
   <v2/>
   <vrfs>
    <vrf>
     <vrf-name>default</vrf-name>
    </vrf>
   </vrfs>
   <netconf>
    <port>830</port>
    <vrfs>
     <vrf>
      <vrf-name>default</vrf-name>
     </vrf>
    </vrfs>
   </netconf>
  </server>
</ssh>
<grpc xmlns=http://cisco.com/ns/yang/Cisco-IOS-XR-um-grpc-cfg>
  /*Configures the gRPC (Google Remote Procedure Call) on a network device*/
  <port>57400</port>
  <no-tls></no-tls>
</grpc>
<hostname xmlns=http://cisco.com/ns/yang/Cisco-IOS-XR-um-hostname-cfg>
 /*Configures the hostname on a network device*/
  <system-network-name>SF-1</system-network-name>
</hostname>
<aaa xmlns=http://cisco.com/ns/yang/Cisco-IOS-XR-um-aaa-cfg>
  <usernames xmlns=http://cisco.com/ns/yang/Cisco-IOS-XR-um-aaa-task-user-cfg>
   /*Configures the AAA (Authentication, Authorization, and Accounting) parameters on a
network device*/
   <username>
    <ordering-index>0</ordering-index>
    <name>cafyauto</name>
    <group>
     <root-lr/>
     <cisco-support/>
    </group>
    <secret>
     <ten>$6$iY.Zo/7E7RIG5o/.$PH1YegMZiHsiRDTxKOjKQ0i8rd4ns2vHMHEmQrsMQrrtNTlj
/gcBEQRXj3WDR8bAv0rWzz3aGdElteshHYXXR1</ten>
    </secret>
   </username>
  </usernames>
  <accounting>
   <commands>
    <accounting-list>
     <list-name>default</list-name>
     <start-stop/>
     <local/>
    </accounting-list>
   </commands>
  </accounting>
 </aaa>
 <line xmlns=http://cisco.com/ns/yang/Cisco-IOS-XR-um-line-cfg>
   <default>
    <exec-timeout xmlns=http://cisco.com/ns/yang/Cisco-IOS-XR-um-line-exec-timeout-cfg>
     /*Configures the exec timeout settings on network devices for the amount of time that
 the software waits for user to input after the last key has been pressed */
     <timeout-in-minutes>0</timeout-in-minutes>
     <timeout-in-seconds>0</timeout-in-seconds>
    </exec-timeout>
    <absolute-timeout
```

```
xmlns=http://cisco.com/ns/yang/Cisco-IOS-XR-um-line-general-cfg>0</absolute-timeout>
    /*Configures line settings on network devices*/
   </default>
 </line>
 </data>
</rpc-reply>
```

Authenticate Data Ports

On fresh boot, ZTP process is initiated from management ports and may switch to data ports. To validate the connection with DHCP server, authentication is performed on data ports through DHCP option 43 for IPv4 and option 17 for IPv6. These DHCP options are defined in option space and are included within **dhcpd.conf** and **dhcpd6.conf** configuration files. You must provide following parameters for authentication while defining option space:

- Authentication code—The authentication code is either 0 or 1; where 0 indicates that authentication is not required, and 1 indicates that MD5 checksum is required.

Note If the option 43 for IPv4, and option 17 for IPv6 is disabled, the authentication fails.

- Client identifier—The client identifier must be 'exr-config' .
- MD5 checksum—This is chassis serial number. It can be obtained using **echo -n $SERIALNUMBER | md5sum | awk '{print $1}'** .

Here is the sample **dhcpd.conf** configuration. In the example below, the option space called **VendorInfo** is defined with three parameters for authentication:

```
class "vendor-classes" {
   match option vendor-class-identifier;
}

option space VendorInfo;
option VendorInfo.clientId code 1 = string;
option VendorInfo.authCode code 2 = unsigned integer 8;
option VendorInfo.md5sum code 3 = string
option vendor-specific code 43 = encapsulate VendorInfo;
subnet 10.65.2.0 netmask 255.255.255.0 {
  option subnet-mask 255.255.255.0;
  option routers 10.65.2.1;
  range 10.65.2.1 10.65.2.200;
}
host cisco-mgmt {
   hardware ethernet 00:50:60:45:67:01;
   fixed-address 10.65.2.39;
   vendor-option-space VendorInfo;
   option VendorInfo.clientId "exr-config" ;
   option VendorInfo.authCode 1;
   option VendorInfo.md5sum "aedf5c457c36390c664f5942ac1ae3829";
   option bootfile-name "http://10.65.2.1:8800/admin-cmd.sh";
}
```

Here is the sample **dhcpd6.conf** configuration file. In the example below, the option space called **VendorInfo** is defined that has code width 2 and length width 2 (as per dhcp standard for IPv6) with three parameters for authentication:

```
log-facility local7;
option dhcp6.name-servers 2001:1451:c632:1::1;
option dhcp6.domain-search "cisco.com";
dhcpv6-lease-file-name "/var/lib/dhcpd/dhcpd6.leases";
option dhcp6.info-refresh-time 21600;
option dhcp6.bootfile-url code 59 = string;
option dhcp6.user-class code 15 = string;
option space CISCO-EXR-CONFIG code width 2 length width 2;
option CISCO-EXR-CONFIG.client-identifier code 1 = string;
option CISCO-EXR-CONFIG.authCode code 2 = integer 8;
option CISCO-EXR-CONFIG.md5sum code 3 = string;
option vsio.CISCO-EXR-CONFIG code 9 = encapsulate CISCO-EXR-CONFIG;
subnet6 2001:1451:c632:1::/64{
 range6 2001:1451:c632:1::2 2001:1451:c632:1::9;
 option CISCO-EXR-CONFIG.client-identifier "exr-config";
 option CISCO-EXR-CONFIG.authCode 1;
 #valid md5
 option CISCO-EXR-CONFIG.md5sum "90fd845ac82c77f834d57a034658d0f0";
 if option dhcp6.user-class = 00:04:69:50:58:45 {
  option dhcp6.bootfile-url "http://[2001:1851:c632:1::1]/cisco-2/image.iso";
 }
 else {
   #option dhcp6.bootfile-url "http://[2001:1851:c632:1::1]/cisco-2/cisco-mini-x.iso.sh";
   option dhcp6.bootfile-url "http://[2001:1851:c632:1::1]/cisco-2/ztp.cfg";
  }
}
```

Setup DHCP Server

For ZTP to operate a valid IPv4 or IPv6 address is required and the DHCP server must send a pointer to the configuration script.

The DHCP request from the router has the following DHCP options to identify itself:

- **Option 60**: “vendor-class-identifier” : Used to Identify the following four elements:
  - The type of client: For example, PXEClient
  - The architecture of The system (Arch): For example: 00009 Identify an EFI system using a x86-64 CPU
  - The Universal Network Driver Interface (UNDI):

    For example 003010 (first 3 octets identify the major version and last 3 octets identify the minor version)
  - The Product Identifier (PID):
- **Option 61**: “dhcp-client-identifier” : Used to identify the Serial Number of the device.
- **Option 66** : Used to request the TFTP server name.
- **Option 67**: Used request the TFTP filename.
- **Option 97**: “uuid” : Used to identify the Universally Unique Identifier a 128-bit value (not usable at this time)

Example

The following DHCP request sample provides a fixed IP address and a configuration file with the mac address of the management interface.

```
host cisco-rp0 {
   hardware ethernet e4:c7:22:be:10:ba;
   fixed-address 172.30.12.54;
   filename "http://172.30.0.22/configs/cisco-1.config";
}
```

The following DHCP request sample provides a fixed IP address and a configuration file with the mac address of the management interface along with capability to re-image the system using iPXE (exr-config option):

```
host cisco-rp0 {
   hardware ethernet e4:c7:22:be:10:ba;
   fixed-address 172.30.12.54;
   if exists user-class and option user-class = "iPXE" {
      filename = "http://172.30.0.22/boot.ipxe";
   } elsif exists user-class and option user-class = "exr-config"  {
      filename = "http://172.30.0.22/scripts/cisco-rp0_ztp.sh";
   }
}
```

DHCP server identifies the device and responds with either an IOS-XR configuration file or a ZTP script as the filename option.

The DHCP server responds with the following DHCP options:

- DHCPv4 using BOOTP filename to supply script/config location.
- DHCPv4 using Option 67 (bootfile-name) to supply script/config location.
- DHCPv6 using Option 59 (OPT_BOOTFILE_URL) to supply script/config location

The following sample shows the DHCP response with bootfile-name (option 67):

```
option space cisco-vendor-id-vendor-class code width 1 length width 1;
option vendor-class.cisco-vendor-id-vendor-class code 9 = {string};

######### Network 11.11.11.0/24 #################
shared-network 11-11-11-0 {

####### Pools ##############
  subnet 11.11.11.0 netmask 255.255.255.0 {
    option subnet-mask 255.255.255.0;
 option broadcast-address 11.11.11.255;
 option routers 11.11.11.2;
 option domain-name-servers 11.11.11.2;
 option domain-name "cisco.local";
 # DDNS statements
   ddns-domainname "cisco.local.";
 # use this domain name to update A RR (forward map)
   ddns-rev-domainname "in-addr.arpa.";
   # use this domain name to update PTR RR (reverse map)

    }

######## Matching Classes ##########

  class "cisco" {
       match if (substring(option dhcp-client-identifier,0,11) = "FGE194714QS");
  }
```

```
  pool {
      allow members of "cisco";
      range 11.11.11.47 11.11.11.50;
      next-server 11.11.11.2;

      if exists user-class and option user-class = "iPXE" {
         filename="http://11.11.11.2:9090/cisco-mini-x-6.2.25.10I.iso";
      }


      if exists user-class and option user-class = "exr-config"
       {
          if (substring(option vendor-class.cisco-vendor-id-vendor-class,19,99)="cisco")
          {
           option bootfile-name "http://11.11.11.2:9090/scripts/exhaustive_ztp_script.py";

          }
        }


      ddns-hostname "cisco-local";
      option routers 11.11.11.2;
  }
}
```

Customize ZTP Initialization File

You can customize the following ZTP configurable options in the *ztp.ini* file:

- `ZTP`: You can enable or disable ZTP at boot using CLI or by editing the *ztp.ini* file.
- `Retry`: Set the ZTP DHCP retry mechanism: The available values are infinite and once.
- `Fetcher Priority`: Fetcher defines which port ZTP should use to get the provisioning details. By default, each port has a fetcher priority defined in the *ztp.ini* file. You can modify the default priority of the fetcher. Allowed range is from 0 to 9.

Note Lower the number higher the priority. The value 0 has the highest priority and 9 has the lowest priority.

In the following example, the Mgmt4 port has the highest priority:

```
[Fetcher Priority]
Mgmt4: 0
Mgmt6: 1
DPort4: 2
DPort6: 3
```

- `progress_bar`: Enable progress bar on the console. By default, the progress bar is disabled. To enable the progress bar, add the following entry in the `ztp.ini` file.

```
[Options]
progress_bar: True
```

By default, the `ztp.ini` file is located in the `/pkg/etc/` location. To modify the ZTP configurable options, make a copy of the file in the `/disk0:/ztp/` directory and then edit the `ztp.ini` file.

To reset to the default options, delete the ztp.ini file in the `/disk0:/ztp/` directory.

Note Do not edit or delete the `ztp.ini` file in the `/pkg/etc/` location to avoid issues during installation.

The following example shows the sample of the `ztp.ini` file:

```
[Startup]
start: True
retry_forever: True

[Fetcher Priority]
Mgmt4:  1
Mgmt6:  2
DPort4: 3
DPort6: 4
```

Enable ZTP Using CLI

If you want to enable ZTP using CLI, use the **ztp enable** command.

Configuration example

```
Router#ztp enable
Fri Jul 12 16:09:02.154 UTC
Enable ZTP? [confirm] [y/n] :y
ZTP Enabled.
```

Disable ZTP Using CLI

If you want to disable ZTP using CLI, use the **ztp disable** command.

Configuration example

```
Router#ztp disable
Fri Jul 12 16:07:18.491 UTC
Disable ZTP? [confirm] [y/n] :y
ZTP Disabled.
Run ZTP enable to run ZTP again.
```

Provision ZTP

When you boot the device, the ZTP process initiates automatically if the device does not have a prior configuration. During the process, the router receives the details of the configuration file from the DHCP server. The ZTP process initiates when you boot the network-device with an IOS-XR image. The process starts only on the device that doesn't have a prior configuration. Here is the high-level work flow of the ZTP process for the Fresh boot:

1. ZTP sends DHCP request to fetch the ZTP configuration file or user script. To help the Bootstrap server uniquely identify the device, ZTP sends below DHCP option
    - DHCP(v4/v6) client-id=Serial Number
    - DHCPv4 option 124: Vendor, Platform, Serial-Number

- DHCPv6 option 16: Vendor, Platform, Serial-Number

The following is the default sequential flow of the ZTP process:

- ZTP sends IPv4 DHCP request first on all the management port. In case there is a failure, then ZTP sends IPv6 DHCP request on all the management port.
- ZTP sends IPv4 DHCP request first on all the data port. In case there is a failure, then ZTP sends IPv6 DHCP request on all the data port.

  The default sequential flow is defined in configuration file and you can modify the sequence using the configuration file.

2. DHCP server identifies the device and responds with DHCP response using one of the following options: DHCP server should be configured to respond with the DHCP options.
   - DHCPv4 using BOOTP filename to supply script/config location
   - DHCPv4 using Option 67 (bootfile-name) to supply script/config location
   - DHCPv6 using Option 59 (OPT_BOOTFILE_URL) to supply script/config location
3. The network device downloads the file from the web server using the URI location that is provided in the DHCP response.
4. The device receives a configuration file or script file from the HTTP server.

Note
- If the downloaded file content starts with !! IOS XR it is considered as a configuration file.
- If the downloaded file content starts with #! /bin/bash, #! /bin/sh or #!/usr/bin/python it is considered as a script file.

5. The device applies the configuration file or executes the script or binary in the default bash shell.
6. The Network device is now up and running.

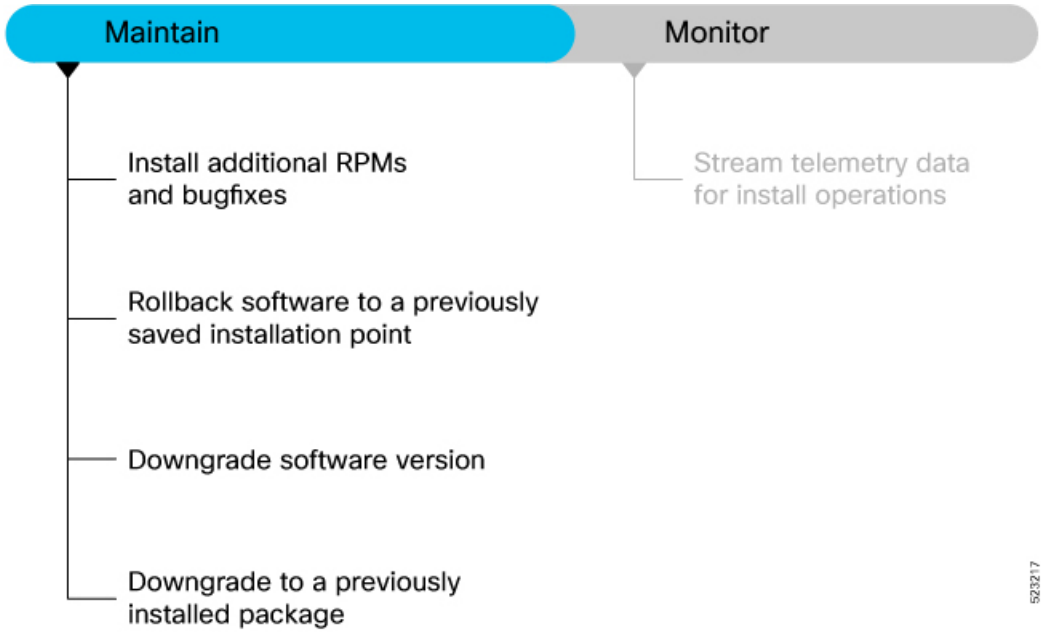
CHAPTER 7

Manage the Router

Use the procedures in this section to maintain the router at optimum conditions and monitor the install operation by streaming telemetry data.

The following workflow shows the tasks involved in managing the software:

Figure 18: Workflow to Manintain and Monitor the Software Installation



This section contains the following topics:

Install Additional RPMs and Bug Fixes

You can install individual optional packages when new features are added or software problems are fixed.

Before you begin

When you upgrade the Cisco IOS XR software, you can also install or remove optional feature packages (RPMs or bug fixes) *before* applying the changes in the router. You can perform this operation while an atomic change is already in progress. However, all packaging operations before this command are discarded.

You can install the packages from a remote repository or copy the files to the router. If you are using a remote repository, ensure you have created and configured an external repository to store the packages. See the Create Repository to Access Install Files, on page 37 topic.

Download the specific additional RPMs and latest bug fix RPMs as tarballs to the repository. If the bug fix has dependencies, we recommend that you create a bug fix tarball that contains all dependencies.The *README* file in the tarball provides relevant information about the bug fix and identifies any dependencies – for example, whether other bug fix RPMs may be required for a complete fix.

Option 1: Install RPMs Using Command Line Interface

Optional RPMs and bug fixes are available as TAR files on the Software Download page. Starting with Cisco IOS XR Release 7.3.1, you are no longer required to manually extract the RPMs from the TAR file; you can install the bug fix RPM directly from the TAR file.

Step 1 Check the available packages in the repository.

Example:

```
Router#show install available

Trying to access repositories...
Package        Architecture        Version            Repository
xr-8000-core    x86_64             7.8.1              remote-repo
xr-core         x86_64             7.8.1              remote-repo
```

Step 2 Install the packages (additional RPMs or bug fixes).

- **Option 1:** Install RPMs without control over reload operation.

  Important This option is not applicable when you downgrade or remove RPMs.

  You can either specify a tarfile (with bug fixes or optional packages), or a repository containing the RPMs. Use this command:

  ```
  Router#install source full-path-to-rpm [all]
  ```

  Specify the **all** keyword if you want to install optional packages. Exclude the **all** keyword if you want to upgrade the packages that are currently installed on the system.

  The *full-path-to-rpm* can be one of the following locations based on where you have saved the files.

  - Local path—files located in or under `/var/xr/disk1/`, `/harddisk:/` or `/misc/disk1/`

- Remote repository or tar file—`ftp://<server>[;<named-vrf>]/<remote_path>`, `https://<server>[;<named-vrf>]/<remote_path>` or `http://<server>[;<named-vrf>]/<remote_path>`

  If you want to add new packages from this source, you must use the **all** keyword:

  ```
  Router#install source full-path-to-rpm all sync
  ```

  Note If the remote repository is reachable through a named VRF, you must mention the named VRF in the above commands. For example,

  ```
  Router#install source http://10.105.57.27;vrf1/repoinfra/install_rpms.tar
  ```

  where **vrf1** is the named VRF through which the remote repository is accessible.

The operation adds the RPMs and applies the change via `reload` or `restart` operation, whichever is least impactful based on the update.

- **Option 2:** Install RPMs with control over reload operation.

  Important This option is applicable when you downgrade, remove or rollback RPMs.

  a. Install RPMs by providing the RPM name, Cisco bug fix ID (example, CSCab12345) or add packages from a specified source. Use the **install package add** command if you want to add new optional packages, else use the **install package upgrade** command.

  ```
  Router#install package add <pkg1> <pkg2> <pkgn>
  ```

  Or

  ```
  Router#install package upgrade <pkg1> <pkg2> <pkgn>
  ```

  b. Apply the changes.

  ```
  Router#install apply [reload | restart]
  ```

  You can use the `reload` or `restart` options based on the change that is installed. To determine whether a `reload` or `restart` is required, check the output of **show install request** or **show install history last transaction verbose** command. The output indicates the required actions.

  ```
  Router#show install history last transaction verbose
  2023-01-25 05:45:37 UTC    Transaction 87 started
  2023-01-25 05:45:37 UTC      Atomic change 87.1 started
  2023-01-25 05:45:37 UTC      Packaging operation 87.1.1 started
  2023-01-25 05:45:37 UTC    Transaction 87 complete

  Least impactful apply method: process restart
  ```

Step 3 Check the status of the install operation.

Example:

```
Router#show install request
User request: No user requests found
State:        Success
Current activity:    No install operation in progress

The following actions are available:

    install package add
    install package remove
    install package upgrade
```

```
install package downgrade
install package replace
install package rollback
install replace
install rollback
install source
```

Note Include the keyword `noprompt` in the commands to enable the system to bypass your permission to reload the router.

Step 4 Verify the image and packages are activated successfully.

Example:

```
Router# show install request
User request: install package add xr-mcast
Operation ID: 87.1.1
State: Success
```

Step 5 Commit the transaction.

Example:

```
Router#install commit
```

Option 2: Install RPMs Using YANG Data Model

Use `Cisco-IOS-XR-install-augmented-act.yang` data model to install the RPMs or bug fixes.

Procedure

	Command or Action	Purpose

Step 1	Use the `install-package-replace` RPC on the data model.
	Example:
	`<install-package-replace>`
	`  <source-type>remote</source-type>`
	`  <source>remote-repo</source>`
	`  <file>rpm-file-name</file>`
	`</install-package-replace>`
		If the install operation lists the repository reachable through a VRF, you must add the VRF name for the operation to be successful.
		`<install-package-upgrade xmlns=http://cisco.com/ns/yang/Cisco-IOS-XR-install-augmented-act>`
		`  <source-type>ftp</source-type>`
		`<source>10.105.57.27;vrf1/repoinfra/install_rpms.tar</source>`
		`</install-package-upgrade>`

Downgrade Software Version

Downgrade the current software version to a previous software release in case of an upgrade failure or based on requirement.

Before you begin

Check the FPD status and ensure that all the FPDs are in `CURRENT` state.

```
Router#show hw-module location all fpd
```

If the FPDs are not in CURRENT state, upgrade the FPDs.

```
Router#upgrade hw-module location all fpd all
```

After all the FPDs are upgraded, reload the router.

```
Router#reload location all
Proceed with reload? [confirm]
```

After the router reloads, check that all the FPDs are in CURRENT state.

Note We do not recommend downgrading the FPDs when you downgrade the system.

Step 1 Determine the supported target versions to downgrade from the current version.

Example:

```
Router#show install upgrade-matrix
```

View the hardware or software limitations, and bridging SMUs required for the version downgrade. For more information about checking compatibility between the current and target versions, see View Supported Upgrade and Downgrade Releases, on page 28.

Downgrading Packages:

Customers can also downgrade user-specified packages (for example, xr-telnet). This is separate from downgrading the entire XR version, but an ISO for an earlier version of XR is used instead of a newer ISO.

Note The downgrade of IOS XR from version 7.3.4 to 7.0.14 for systems with Open PID RP can cause route processor BIOS corruption. We recommend that you do not downgrade below version 7.3.16.

Step 2 Back up the file system of the current version for recovery purposes.

Example:

Copy the running configuration to the harddisk: directory on the router:

```
Router#copy running-config harddisk:/running_config-<mmddyyyy>
```

Copy the running configuration to a remote server:

```
Router#scp harddisk:/ running_config user@<ip-address>:<location>
```

Step 3 Download the target version from the Software Download Center.

Step 4 You can either install from the remote repository or copy the ISO image file to the /harddisk: of the router.

Example:

```
Router#scp root@<ip-address>:/<dir>/8000-x64-release.iso harddisk:
```

Step 5 Verify that the MD5 checksum of the copied target file matches with the MD5 value of the source on the Software Download Center.

Example:

```
Router#show md5 file /harddisk:/8000-x64-<target-version>.iso
```

Step 6 Install the base image to downgrade the system.

- **Option 1:** Install ISO without control over reload timing.

  ```
  Router#install replace /harddisk:/8000-x64-release.iso
  ```

  The image is installed, the changes are applied through a reload or a restart of the system, and commits the changes. However, you do not have control over the timing of the reload or restart —these occur as soon as the package operation completes and the system is ready.

  If you want to control when your system reloads (management of a network outage), we recommend that you schedule a downgrade window and perform an **install replace** operation, letting the system reload without intervention.

- **Option 2:** Install ISO with control over reload timing.

  a. Install the image.

  ```
  Router#install package replace /harddisk:/8000-x64-release.iso
  ```

  b. Apply the changes.

  ```
  Router#install apply [reload | restart]
  ```

  You can use either the `reload` or `restart` options based on the file that is installed. To determine whether a `reload` or `restart` is required, check the output of **show install request** command. The output indicates the required actions.

Step 7 After the base image is downgraded, install the additional packages. For more information, see Install Additional RPMs and Bug Fixes, on page 88.

During an install operation, if the system reboots unexpectedly or an apply by reload results in the system failing to boot, it automatically recovers to its software state before the current transaction.

Downgrade to a Previously Installed Package

You can downgrade a package to a previously installed version. By default, the subsequent previous version (version previous to the current version) is installed. Also, you can downgrade the software to a specific version of interest. To remove a bug fix RPM from the installed packages, downgrade the package to a version where the fix was not applied.

Note While downgrading, you can choose any previous version, including the base version of the RPM. However, when downgrading a bug fix RPMs, ensure that you also consider all dependencies of the current version.

Bug fix RPM is an upgrade to the existing package. The action of removing a bug fix RPM either removes the entire feature, or fails if the package is mandatory.

You can use the **show install fixes deactivate** command to view information related to removing a bug fix. This command provides information such as the package changes, other bug fixes that get deactivate, instructions for adding packages missing for the bug fix removal to be successful, command for removing the bug fix, and any recommendations, if applicable. See the following example:

Note You can specify any number of DDTS seperated by a space in the **show install fixes deactivate** command. For example, to know the recommendations for removing bug fix for ABC123, DEF456, and GHI789, you can use **show install fixes deactivate ABC123 DEF456 GHI789** command.

```
Router#show install fixes deactivate CSCwc26944

User-requested DDTSs deactivated by this command: CSCwc26944

All DDTSs deactivated by this command: CSCvs01738,CSCwc26944

Package changes:
  xr-8000-core-7.5.2v1.0.5 -> xr-8000-core-7.5.2v1.0.4
  xr-8000-fib-ea-7.5.2v1.0.1 -> xr-8000-fib-ea-7.5.2v1.0.0           (missing)
  xr-8000-leabaofa-7.5.2v1.0.3 -> xr-8000-leabaofa-7.5.2v1.0.2
  xr-8000-mcast-7.5.2v1.0.1 -> xr-8000-mcast-7.5.2v1.0.0             (missing)
  xr-8000-utapp-blaze-7.5.2v1.0.2 -> xr-8000-utapp-blaze-7.5.2v1.0.1
  xr-fib-7.5.2v1.0.3 -> xr-fib-7.5.2v1.0.2
  xr-mcast-7.5.2v1.0.1 -> xr-mcast-7.5.2v1.0.0                       (missing)
  xr-ncs540l-core-7.5.2v1.0.14 -> xr-ncs540l-core-7.5.2v1.0.10
  xr-ncs5700-core-7.5.2v1.0.14 -> xr-ncs5700-core-7.5.2v1.0.10
  xr-ofa-7.5.2v1.0.3 -> xr-ofa-7.5.2v1.0.1
  xr-snmp-7.5.2v1.0.1 -> xr-snmp-7.5.2v1.0.0                         (missing)

Example install commands:
  install source any-configured xr-8000-core-7.5.2v1.0.4 xr-8000-fib-ea-7.5.2v1.0.0
xr-8000-leabaofa-7.5.2v1.0.2 xr-8000-mcast-7.5.2v1.0.0 xr-8000-utapp-blaze-7.5.2v1.0.1
xr-fib-7.5.2v1.0.2 xr-mcast-7.5.2v1.0.0 xr-ncs540l-core-7.5.2v1.0.10
xr-ncs5700-core-7.5.2v1.0.10 xr-ofa-7.5.2v1.0.1 xr-snmp-7.5.2v1.0.0
  install package downgrade xr-8000-core-7.5.2v1.0.4 xr-8000-fib-ea-7.5.2v1.0.0
xr-8000-leabaofa-7.5.2v1.0.2 xr-8000-mcast-7.5.2v1.0.0 xr-8000-utapp-blaze-7.5.2v1.0.1
xr-fib-7.5.2v1.0.2 xr-mcast-7.5.2v1.0.0 xr-ncs540l-core-7.5.2v1.0.10
xr-ncs5700-core-7.5.2v1.0.10 xr-ofa-7.5.2v1.0.1 xr-snmp-7.5.2v1.0.0

IMPORTANT: The above commands cannot currently be run because there are missing packages.Put
 the following packages in an accessible repository.
  xr-8000-fib-ea-7.5.2v1.0.0
  xr-8000-mcast-7.5.2v1.0.0   (optional package)
  xr-mcast-7.5.2v1.0.0        (optional package)
  xr-snmp-7.5.2v1.0.0

IMPORTANT: If the optional packages are not available, then they can be completely removed
 before removing the DDTS using install package remove xr-8000-mcast-7.5.2v1.0.0
xr-mcast-7.5.2v1.0.0
```

The following example shows the package `xr-telnet-7.0.11v1.0.1` is downgraded to `xr-telnet-7.0.11v1.0.0`. The path to source can be a local location or a configured repository.

Before you begin

Ensure you have access to the previously installed package and its source.

Step 1 Downgrade the package using one of the following options:

- Downgrade the package where the fix was applied. When multiple older versions of the package are present in the configured repositories, the immediate previous version of the package is installed. Use caution when using this command as the current version of the package is removed completely.

```
Router#install package downgrade xr-telnet
```

Apply the changes.

```
Router#install apply [reload | restart]
```

Attention To identify whether to reload the router or restart the affected processes as part of the apply operation, use either **show install history last transaction verbose** command or **show install request** command.

- Install a specific earlier version of the optional package. The changes are applied automatically.

  Attention An automatic change may trigger a reload of the router depending on the package being downgraded.

  ```
  Router#install source <path-to-source> xr-telnet-7.0.1v1.0.0
  ```

- Use `install` RPC on the `Cisco-IOS-XR-install-act.yang` data model. Here is an example usage with a local repository:

  ```
  <install>
   <packages>
     <packagename>
      xr-telnet-7.0.11v1.0.0

  </packagename>
   </packages>
     <source>file://<path-to-source>/</source>
  </install>
  ```

  The package version `xr-telnet-7.0.11v1.0.1` is downgraded to `xr-telnet-7.0.11v1.0.0`.

Step 2 Commit the operation.

Example:

```
Router#install commit
```

Rollback from SONiC to Cisco IOS XR OS

This section describes how to rollback from SONiC OS to Cisco IOS XR software on the router.

Before you begin

Complete these prerequisites before you install Cisco IOS XR software on a router running SONiC:

- Ensure all SONiC instance are running with FPD version 0.1.

  ```
  root@sonic#cardevent.py --send CV_FPDPUBLISH --slot all
  root@sonic#fpd-util.py --getfpd
  1.0.0.13_programed 0.1
  1.0.0.3_programed 0.1
  1.0.0.5_programed 0.1
  1.0.0.33_programed 0.1
  ```

- Ensure that chassis can access the DHCP or PXE server hosting the IOS XR image.
- Check the BIOS version on RP and LC to ensure that the BIOS version required for IOS XR boot operation is available.

  RP:

```
cisco@sonic#fwutil show status
Chassis    Module    Component    Version    Description
---------  --------  -----------  ---------  -------------------------------
8800-RP              BIOS         1-25       BIOS - Basic Input Output System
                     Aldrin       1.2        Marvell - Aldrin Ethernet switch
                     Aikido       1.35       Aikido - x86 FPGA
                     TAM          2.5        TAM FW - x86
```

LC:

```
cisco@sonic#fwutil show status
Chassis      Module    Component    Version    Description
-----------  --------  -----------  ---------  -------------------------------
8800-LC-48H            BIOS         1-25       BIOS - Basic Input Output System
                       Aldrin       -1.65535   Marvell - Aldrin Ethernet switch
```

- Copy the IOS XR image to router as `onie-recovery-x86_64-cisco_8000-r0.efi64.pxe` image.

  RP:

  ```
  cisco@sonic#ifconfig eth0 192.0.2.254 netmask 255.255.0.0
  ```

  Linux:

  ```
  node$:scp 8000-x64-7.10.1.iso cisco@192.0.2.254:/ws/
  ```

  RP:

  ```
  cp /ws/8000-x64-7.10.1.iso
  /opt/cisco/var/tftp/onie-recovery-x86_64-cisco_8000-r0.efi64.pxe
  ```

Step 1 Run the migration script.

Example:

```
root@sonic#xrmigration.sh
   INFO: Staging LC found : 1.0.0.3
   INFO: ipxe container start
   INFO: ipxe container service already running
   INFO: override ONIE image with XR image on staging LC
   INFO: Create dummy sonic image as onie-installer.bin on staging LC for SONiC ipxe server
   INFO: XR ethswitch upgrade on all LC
   INFO: Set migration context at staging LC0
   INFO: Set migration context at RP
   Reload all cards in 30 sec
Handling chassis reload scenario...
```

After two reloads, the RP reaches the iPXE server to automatically install the IOS XR image.

Step 2 Reload all line cards.

Example:

```
Router#reload boot media network location LC
```

Step 3 Verify the status of the cards.

Example:

```
Router#show platform
Thu Jun  1 21:38:26.276 UTC
Node              Type                  State                 Config state
--------------------------------------------------------------------------------
0/RP0/CPU0        8800-RP(Active)       IOS XR RUN            NSHUT
0/0/CPU0          88-LC0-36FH           IOS XR RUN            NSHUT
```

```
0/1/CPU0          8800-LC-48H             IOS XR RUN              NSHUT
0/5/CPU0          88-LC0-36FH-M           IOS XR RUN              NSHUT
0/FC0             8808-FC0                OPERATIONAL             NSHUT
0/FT0             8808-FAN                OPERATIONAL             NSHUT
0/FT1             8808-FAN                OPERATIONAL             NSHUT
0/FT2             8808-FAN                OPERATIONAL             NSHUT
0/FT3             8808-FAN                OPERATIONAL             NSHUT
0/PT0             8800-HV-TRAY            OPERATIONAL             NSHUT
0/PT1             8800-HV-TRAY            OPERATIONAL             NSHUT
0/PT2             8800-HV-TRAY            OPERATIONAL             NSHUT
```

Step 4 After IOS XR software is installed on both RP and LC, reload all the nodes on the router.

Example:

```
Router#reload location all
```

The OS is migrated from SONiC to Cisco IOS XR software.

Stream Telemetry Data for Install Operations

Table 10: Feature History Table

Feature Name	Release Information	Description
Stream Telemetry Data about Install Operations	Release 7.5.2	You can stream telemetry data for install-related details such as active and committed packages, view the progress of install operations, retrieve the image version, and view the error messages with recovery information when an operation fails.

To stream telemetry data that is related to software installation, you must create subscriptions to the sensor paths in the YANG data models. See *Obtain Data Models for Install Operation* for the list of supported data models. For information about establishing a telemetry session and creating subscriptions, see the *Telemetry Configuration Guide for Cisco 8000 Series Routers*.

Stream Telemetry Data About	Description	YANG Path
Summary of active packages	Data is streamed after a successful **apply** operation. An active package is the software currently running on the system.	`Cisco-IOS-XR-install-oper: install/packages/active/summary`
Summary of committed packages	Data is streamed after a successful **commit** operation. A package that is committed remains active following a system reload.	`Cisco-IOS-XR-install-oper: install/packages/committed/summary`

Stream Telemetry Data About	Description	YANG Path
Status of the last request operation	Data is streamed when starting a new request and also when entering an `idle` state. If the operation has failed, this includes error messages along with recovery state.	`Cisco-IOS-XR-install-oper: install/request`
Image version and GISO label	Data is streamed after a successful **apply** operation.	`Cisco-IOS-XR-install-oper: install/version`
Packaging information	Data is streamed at the start and end of a packaging operation.	`Cisco-IOS-XR-install-augmented-oper: install/history/latest-packaging-operation`
Atomic information	Data is streamed at the start and end of **apply** operation.	`Cisco-IOS-XR-install-augmented-oper: install/history/latest-atomic-change`
Transaction information	Data is streamed at the start, in progress, and end of a **commit** operation. **Note** After a transactional rollback, some of the data such as summary of active packages, image version can change. However, telemetry events are not sent after the reload operation.	`Cisco-IOS-XR-install-augmented-oper: install/history/latest-transaction`

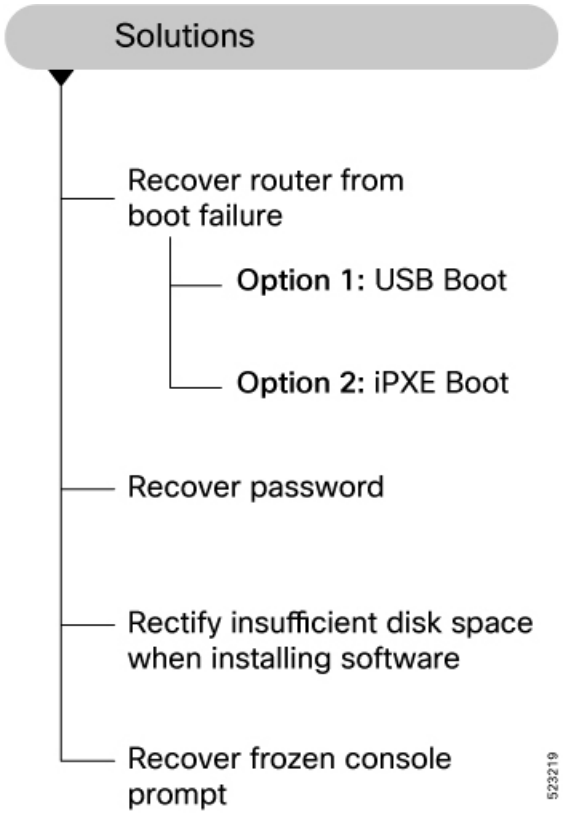
CHAPTER 8

Troubleshoot Router Setup and Upgrade

Use the procedures in this section to troubleshoot router bring-up, software upgrade or downgrade by understanding the problem, probable cause, and the solution.

The following image shows the tasks involved in finding solutions to router setup and upgrade issues:

Figure 19: Solutions to Troubleshoot Software Setup and Upgrade



This section contains the following topics:

Recover Router From Boot Failure

If the command line interface is not accessible, you can recover the router from a boot failure using one of these recovery methods.

Boot the Router Using USB Drive

Problem:

After installing the hardware, you boot the router after connecting to the console port and powering ON the router. The router initiates the boot process using the pre-installed operating system (OS) image. But the router fails to boot, times out or stops responding after the boot process initializes.

Cause:

The router does not boot if an install image is not present on the router or the image is corrupt.

Solution:

Boot the router using a bootable USB flash drive.

The bootable USB flash drive is used to reimage the router during system upgrade or boot the router in case of boot failure. During the USB boot process, the router is re-imaged with the version available on the USB flash drive.

To boot the router using a USB flash drive, you need the following devices:

- A local machine (Windows, Linux, or MAC) with USB Type-A.
- USB flash drive with a storage capacity that is between 8GB (min) and 32 GB (max). USB 2.0 and USB 3.0 are supported.

Note USB Type-C is not supported.

Step 1 Create a bootable USB flash drive from your local machine (Windows or MAC):

a) Connect the USB flash drive to your local machine and format it with File Allocation Table (FAT) 32 file system using the Windows Operating System or Apple MAC Disk Utility. Formatting the USB drive to FAT creates addressable sectors that ensures that each piece of information in the file can be found by the computer.

After formatting the USB flash drive, right-click on the USB disk and view the properties.

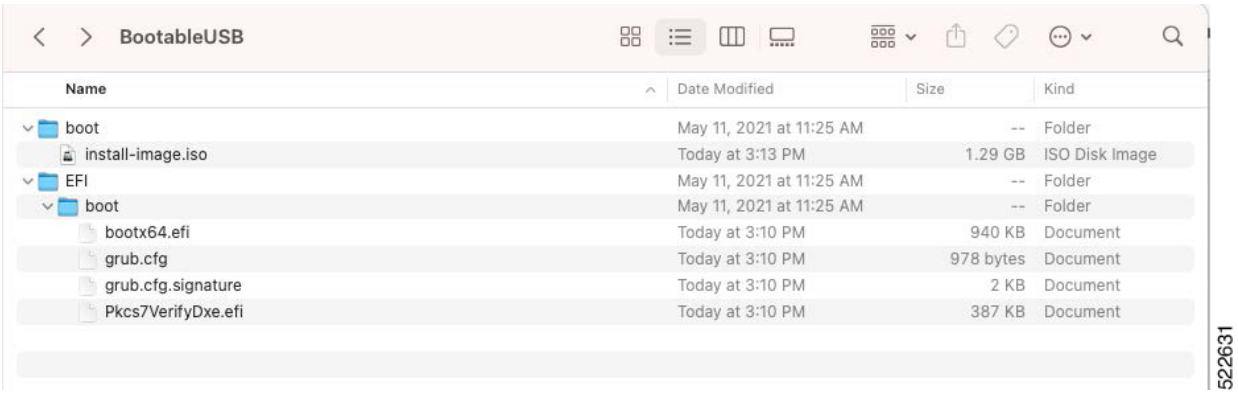
b) On the Software Download page, navigate to the required Cisco IOS XR product and release. The USB boot image is available in the format `<platform>-usb-<version>.zip` compressed file. For example, the USB boot image for Cisco 8000 series routers for release 7.10.1 is `8000-x64-usb-7.10.1.zip` file.

c) Download the compressed USB boot image from the Software Download page to your host computer.

d) Verify that the copy operation is successful. To verify, compare the file size on the Software Download page and the copied file on your computer. You can also verify the MD5 checksum value. This value ensures that the copied file is valid and untampered.

e) Unzip the file to extract the content of the compressed boot file inside the USB flash drive. This converts the USB flash drive to a bootable drive.

Figure 20: Bootable USB Files



Note The content of the zipped file (`EFI` and `boot` directories) should be extracted directly into the root of the USB flash drive. If the unzipping application places the extracted files in a new folder, move the `EFI` and `boot` directories to the root folder of the USB flash drive.

f) Remove the USB flash drive from your computer.

The USB flash drive is ready to be used as a bootable disk to install and boot the Cisco IOS XR image.

Step 2 Boot the router using the bootable USB flash drive.

a) Use this procedure only on active RP; the standby RP must either be powered OFF or removed from the chassis. After the active RP is installed with images from USB, insert or power ON the standby RP as appropriate.

b) Connect to the console.

c) Insert the USB flash drive in the USB Port Type-A on the router.

Ensure that the router is powered ON. When the USB bootable drive is plugged into an operational router, the device is detected as disk2:. Verify using **show media location all** command.

```
Router#show media location all
Fri Jan 27 08:29:00.808 UTC

Media Info for Location: node0_RP0_CPU0
Partition         Size           Used          Percent        Avail
------------------------------------------------------------------
rootfs:           54.4G          16.5G          30%           38G
data:             77.3G          20.5G          27%           56.8G
disk0:            3.9G           12M            1%            3.6G
/var/lib/docker   6.6G           17M            1%            6.2G
disk2:            15G            6.1G           42%           8.6G
log:              5.3G           572M           12%           4.4G
harddisk:         61G            19G            32%           39G
```

d) View the contents of the USB drive.

Example:

```
Router#dir disk2:
```

e) Initiate the reimage from the USB bootable drive.

Example:

```
Router#reload bootmedia usb noprompt
```

Note If the router was powered OFF, power ON the router. Press the `Esc` key continuously to pause the boot process and get the RP to the BIOS menu. Use the arrow key and navigate to the `USB Flash Memory` option in the **Boot Manager** menu, and press the `Enter` key. The BIOS GRUB automatically detects the image from the USB flash drive, starts the installation, and displays the progress of the installation operation.

The router reboots after the reimage with new version available in the USB drive. After the installation is complete, the router reboots and enters the prompt to configure the root username and password.

Boot the Router Using iPXE

Problem:

You connect to the console port and power ON the router. The router initiates the boot process using the pre-installed operating system (OS) image. But the router fails to boot, times out or stops responding after the boot process initializes.

Cause:

The router does not boot if an install image is not present on the router or the image is corrupt.

Solution:

Boot the router using the image from an iPXE server.

iPXE is a pre-boot execution environment that is included in the network card of the management interfaces. It works at the system firmware (UEFI) level of the router. iPXE enables network boot for a router that is offline. The bootloader downloads and installs the ISO image located on an HTTP, FTP, or TFTP server. iPXE boot re-images the router. iPXE acts as a boot loader and provides the flexibility to choose the image that the system will boot based on the Platform Identifier (PID), the serial number, or the management MAC address. iPXE must be defined in the DHCP server configuration file.

Step 1 Configure the DHCP server for IPv4, IPv6, or both communication protocols before you use the iPXE boot.

a) Create `dhcpd.conf` file in `/etc/` or `/etc/dhcp` directory. This configuration file stores the network information such as the path to the script, location of the ISO install file, location of the provisioning configuration file, serial number, MAC address of the router. The following example shows a sample `dhcpd.conf` file.

Example:

```
allow bootp;
allow booting;
ddns-update-style interim;
option domain-name "cisco.com";
option time-offset -8;
ignore client-updates;
default-lease-time 21600;
max-lease-time 43200;
option domain-name-servers <ip-address-server1>, <ip-address-server2>;
log-facility local0;
 :
subnet <subnet> netmask <netmask> {
  option routers <ip-address>;
  option subnet-mask <subnet-mask>;
  next-server <server-addr>;
}
```

```
  :
host <hostname> {
  hardware ethernet e4:c7:22:be:10:ba;
  fixed-address <address>;
  filename "http://<address>/<path>/<image.bin>";
```

b) Test the server once the DHCP server is running. For example, for IPv4 protocol:

- Use the MAC address of the router:

Note Using the `host` statement provides a fixed address that is used for DNS, however, verify that option `77` is set to iPXE in the request. This option is used to provide the boot file to the system when required.

```
host <platform>
{
hardware ethernet <router-mac-address>;
if exists user-class and option user-class = "iPXE" {
 filename = "http://<httpserver-address>/<path-to-image>/<image>";
}
```

Ensure that the above configuration is successful.

- Use the serial number of the router:

```
host <platform>
{
option dhcp-client-identifier "<router-serial-number>";
  filename "http://<IP-address>/<path-to-image>/<image>";
  fixed-address <IP-address>;
}
```

The serial number of the router is derived from the BIOS and is used as an identifier.

Step 2 Recover the router using iPXE boot.

a) Connect to the console.
b) Power ON the router.
c) Press `Esc` key continuously to pause the boot process and get the RP to the BIOS menu.
d) Use the arrow key and navigate to the `Built-in EFI iPXE` option in the **Boot Manager** menu, and press the `Enter` key.

Example:

```
iPXE> ifstat
net0: 00:a0:c9:00:00:00 using i350-b on PCI01:00.0 (closed)
  [Link:up, TX:0 TXE:0 RX:0 RXE:0]
net1: 00:a0:c9:00:00:01 using i350-b on PCI01:00.1 (closed)
  [Link:up, TX:0 TXE:0 RX:0 RXE:0]
net2: 00:a0:c9:00:00:02 using i350-b on PCI01:00.2 (closed)
  [Link:down, TX:0 TXE:0 RX:0 RXE:0]
  [Link status: Down (http://ipxe.org/38086193)]
net3: 00:a0:c9:00:00:03 using i350-b on PCI01:00.3 (closed)
  [Link:down, TX:0 TXE:0 RX:0 RXE:0]
  [Link status: Down (http://ipxe.org/38086193)]
net4: 00:00:00:00:00:04 using dh8900cc on PCI02:00.1 (closed)
  [Link:down, TX:0 TXE:0 RX:0 RXE:0]
  [Link status: Down (http://ipxe.org/38086193)]
net5: 00:00:00:00:00:05 using dh8900cc on PCI02:00.2 (closed)
  [Link:down, TX:0 TXE:0 RX:0 RXE:0]
  [Link status: Down (http://ipxe.org/38086193)]
net6: 04:62:73:08:57:86 using dh8900cc on PCI02:00.3 (closed)
  [Link:up, TX:0 TXE:0 RX:0 RXE:0]

iPXE> set net6/ip 10.0.0.0
iPXE> set net6/netmask 255.0.0.0
```

```
iPXE> set net6/gateway 10.48.42.1
iPXE>
iPXE> ifopen net6

iPXE> ping 10.48.42.1
64 bytes from 10.48.42.1: seq=1
64 bytes from 10.48.42.1: seq=2
Finished: Operation canceled (http://ipxe.org/0b072095)
```

e) Boot the image using one of the following options:

- Option 1: Boot with ISO image. After the reimage is successful, add optional RPMs, bug fixes and update running configuration file.
- Option 2: [Preferred option] Boot with Golden ISO (GISO) image that contains the ISO image, optional RPMs, bug fixes and configuration file. Booting with GISO saves time by eleminating the need to update the files individually.

You must keep the standby RP in the BIOS while installing the image on the active RP.

```
BIOS Ver: 09.19 Date: xx/xx/xxxx 17:02:33

Press <DEL> or <ESC> to enter boot manager.                                    iPXE initialising
devices...ok



iPXE 1.0.0+ (5fbe7) -- Open Source Network Boot Firmware -- http://ipxe.org
Features: DNS HTTP TFTP VLAN EFI ISO9660 NBI Menu
BootMode : 1
Trying net0...
net0: 00:00:01:1c:00:00 using i350-b on PCI01:00.0 (open)
  [Link:up, TX:0 TXE:0 RX:0 RXE:0]
Configuring (net0 00:00:01:1c:00:00)................... ok
net0: 127.0.0.28/255.0.0.0
net0: fe80::2a0:c9ff:fe00:0/64
net1: fe80::2a0:c9ff:fe00:1/64 (inaccessible)
net2: fe80::2a0:c9ff:fe00:2/64 (inaccessible)
net3: fe80::2a0:c9ff:fe00:3/64 (inaccessible)
net4: fe80::200:ff:fe00:4/64 (inaccessible)
net5: fe80::200:ff:fe00:5/64 (inaccessible)
net6: fe80::662:73ff:fe08:1dba/64 (inaccessible)
Next server: 127.0.0.27
Filename: http://127.1.1.27/system_image.iso
http://127.1.1.27/<image>... ok
```

The BIOS GRUB automatically detects the image from the iPXE server, starts the installation, and displays the progress of the installation operation. After the installation is complete, the router reboots and enters the prompt to configure the root username and password.

You can also boot the router from the iPXE server by using the **hw-module location all bootmedia network reload** command.

```
Router# hw-module location all bootmedia network reload
Wed Dec 23 15:29:57.376 UTC
Reload hardware module ? [no,yes]
```

This command configures the router to perform a network-based boot across all modules in the router before a restart. Upon reload, the router attempts to load the operating system image from the specified iPXE server.

Recover Password

Problem:

Unable to access the router due to incorrect login credentials.

Cause:

A root password is used to login to the router. If you forget this root password, you cannot access the router.

Solution:

If you lose your admin and root user credentials, the router becomes inaccessible. The system can be recovered using a router reimage using iPXE or USB boot. However, this approach is not scalable.

You can use the **system recovery** feature to recover the lost password.

With this feature, the system is recovered without the need to reimage the router. The system is recovered to its initial state with the current running software. The installed software and SMUs are retained after the system is recovered. The process complies with the Cisco Product Security Baseline (PSB) where user data is securely erased before recovering the router. The following data that are generated at run-time are erased:

- XR and admin configuration including the password data
- Cryptographic keys on the disk
- Data on encrypted partition
- Generated core files
- SNMP interface index files
- Third-party application (TPA) software and data
- Files created by the user

Use the following procedure on both RP0 nd RP1 cards on the chassis to recover the password.

Note This procedure is applicable only when you have already enabled the password recovery feature on your router.

```
Router(config)#system recovery
```

Step 1 Power ON the router, and press the `ESC` on the RP console to enter the BIOS GRUB menu.

This procedure must be executed on each RP (RP0 and RP1) individually on a modular system.

Step 2 Boot on the standby RP. Press `ESC` key to enter the GRUB (bootstrap program) menu.

Step 3 On the RP0 card console select the **IOS-XR-recovery** option from the GRUB menu and press **Enter**.

Example:

RP0:

Figure 21: IOS XR Recovery Option in GRUB Menu

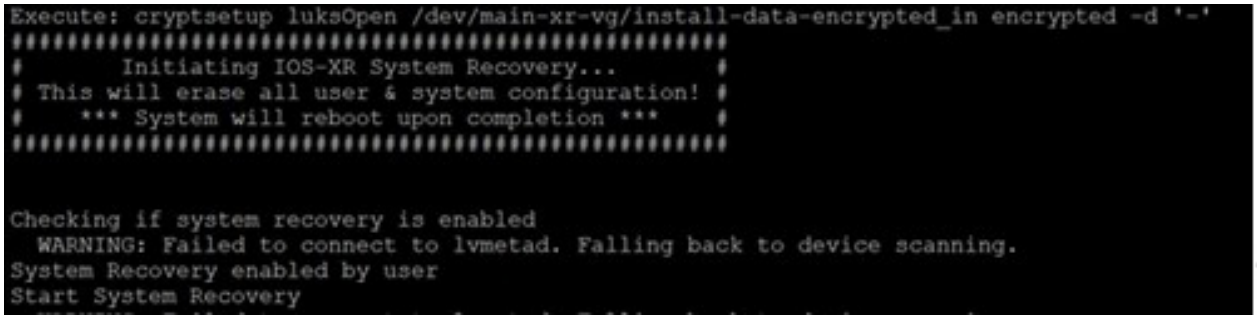
Step 4 Select the **IOS-XR-recovery** option from the GRUB menu and press **Enter** on the RP1 card console when the `Initiating IOS-XR System Recovery...` message is displayed on the RP0 card console.

Note Do not wait until the RP0 card reaches the `Enter root-system username:` prompt. If you reach this prompt, the RP1 card will reload automatically and exit the BIOS GRUB menu. The RP0 card will boot up as active and the RP1 card will boot up as a standby card post the recovery process.

Example:

RP0:

Figure 22: Recovery of RP0



Example:

RP1:

Figure 23: Recovery of RP1

Step 5 On the RP0 card, create a new root user and password. Log in to the router using the new root username and password.

The router boots with the default configuration. Proceed with configuring the router or load a configuration from a backup file if you had already taken a backup. It is recommended to backup data and save the configuration on an external server.

Ensure that you see this message in the RP0 console. If this message is not displayed, then repeat the process from step 1 to step 5 until you see the message:

```
RP/0/RP1/CPU0:June 10 06:13:24.551 CEST: sys_rec[1188]: %SECURITY-SYSTEM_RECOVERY-1-REPORT :
System Recovery at 06:10:19 CEST Fri June 10 2022 was successful

RP/0/RP1/CPU0:June 10 06:15:13.967 CEST: sys_rec[1188]: %SECURITY-SYSTEM_RECOVERY-1-REPORT :
System Recovery
```

The password recovery procedure is complete.

The option to recover the system using console port is disabled on bootup because all the previous configurations are erased. With this configuration disabled, if you select **IOS-XR-recovery** option from GRUB menu to recover the system, the recovery is skipped. Enable the password recovery feature again using the **system recovery** command.

Rectify Insufficient Disk Space When Installing Software

Problem:

The software installation terminates with the error `Error on 0/1/CPU0: Insufficient disk space to install packages.`

Cause:

To install the Cisco IOS XR software, an unused disk space of so-and-so must be available on the router. If this space is not available before installing the software, the installation process terminates with the error.

Solution:

Identify the required disk space using the **show install log** or **install add** command.

View the space consumed by the harddisk: location using the **show media location all** command.

```
Router#show media location all
Wed Jan 8 08:29:00.808 UTC

Media Info for Location: node0_RP0_CPU0
Partition                          Size     Used  Percent    Avail
-------------------------------------------------------------------
rootfs:                          54.4G    16.5G      30%      38G
data:                            77.3G    20.5G      27%    56.8G
disk0:                            3.9G      12M       1%     3.6G
/var/lib/docker                   6.6G      17M       1%     6.2G
disk2:                             15G     6.1G      42%     8.6G
log:                              5.3G     572M      12%     4.4G
harddisk:                          61G      19G      32%      39G

Media Info for Location: node0_RP1_CPU0
Partition                          Size     Used  Percent    Avail
-------------------------------------------------------------------
rootfs:                          54.3G    16.5G      30%    37.9G
data:                            77.4G    46.1G      60%    31.4G
disk0:                            3.9G     8.5M       1%     3.6G
/var/lib/docker                   6.6G      19M       1%     6.2G
log:                              5.3G     492M      10%     4.5G
harddisk:                          61G      44G      78%      14G

Media Info for Location: node0_0_CPU0
Partition                          Size     Used  Percent    Avail
-------------------------------------------------------------------
rootfs:                          54.4G    10.1G      18%    44.4G
data:                            77.3G     1.9G       2%    75.5G
/var/lib/docker                   6.6G      16M       1%     6.2G
disk0:                            3.9G     8.2M       1%     3.6G
harddisk:                          61G     109M       1%      57G
log:                              5.3G     372M       8%     4.6G

Media Info for Location: node0_6_CPU0
Partition                          Size     Used  Percent    Avail
-------------------------------------------------------------------
rootfs:                          54.4G    10.1G      18%    44.4G
data:                            77.3G     1.9G       2%    75.4G
disk0:                            3.9G     8.3M       1%     3.6G
/var/lib/docker                   6.6G      16M       1%     6.2G
harddisk:                          61G     154M       1%      57G
log:                              5.3G     374M       8%     4.6G
RP/0/RP0/CPU0:R1#
```

Use the following procedure to free up the disk space to make room for the software installation.

Step 1 Remove inactive packages from the system.

Example:

View the inactive packages:

```
Router(admin)#show install inactive
6 inactive package(s) found:
    ncs5500-xr-6.6.1
    ncs5500-k9sec-3.1.0.0-r661
    ncs5500-mpls-2.1.0.0-r661
```

```
    ncs5500-isis-2.1.0.0-r661
    ncs5500-mcast-2.1.0.0-r661
    ncs5500-mgbl-3.0.0.0-r661
```

Remove the inactive packages:

```
Router(admin)#install remove inactive all synchronous
   instdir[198]: %INSTALL-INSTMGR-6-INSTALL_OPERATION_STARTED :
Install operation 8 '(admin) install remove inactive all' started by user 'user_b'
Install operation 8 '(admin) install remove inactive all' started by user 'user_b' at
   09:25:41 UTC Fri June 10
Info:     This operation will remove the following package:
ncs5500-xr-6.6.1
    ncs5500-k9sec-3.1.0.0-r661
    ncs5500-mpls-2.1.0.0-r661
    ncs5500-isis-2.1.0.0-r661
    ncs5500-mcast-2.1.0.0-r661
    ncs5500-mgbl-3.0.0.0-r661
Proceed with removing these packages? [confirm]
The install operation will continue synchronously.
```

Step 2 Remove stale or unnecessary files from the harddisk: location such as cores, debug logs, kdump and showtech data. We recommended that you do not remove files from other partitions because these locations may contain files that are relevant to collecting debug information. Carefully inspect the files to be deleted.

Example:

```
Router#rmdir harddisk:
Remove directory filename []?newdir
Delete harddisk:/newdir[confirm]y
```

Use the **delete** command to remove specific directory or files. When a directory contains files such as images, bug fixes or configuration files, you must remove the files before deleting the directory.

```
Routert#delete harddisk:/file
```

Verify that the unwanted directory is removed from the harddisk.

```
Router#dir harddisk:
 Directory of harddisk:
 37146       drwx  4096        Sun Dec 14 15:30:48 2008  malloc_dump
 43030       drwx  4096        Wed Dec 24 11:20:52 2008  tracebacks
 43035       drwx  4096        Thu Jan  8 18:59:18 2009  sau
 51026       drwx  4096        Sat Dec 27 02:52:46 2008  tempA
 51027       drwx  4096        Sat Dec 27 02:04:10 2008  dir.not.del
 -430307552  -rwx  342         Fri Jan 16 10:47:38 2009  running-config
 -430305504  -rwx  39790       Mon Jan 26 23:45:56 2009  cf.dat
39929724928 bytes total (39883235328 bytes free)
```

Recover Frozen Console Prompt

Problem:

The console access is frozen and does not respond. In this state, no output or input characters are displayed on the console.

Cause:

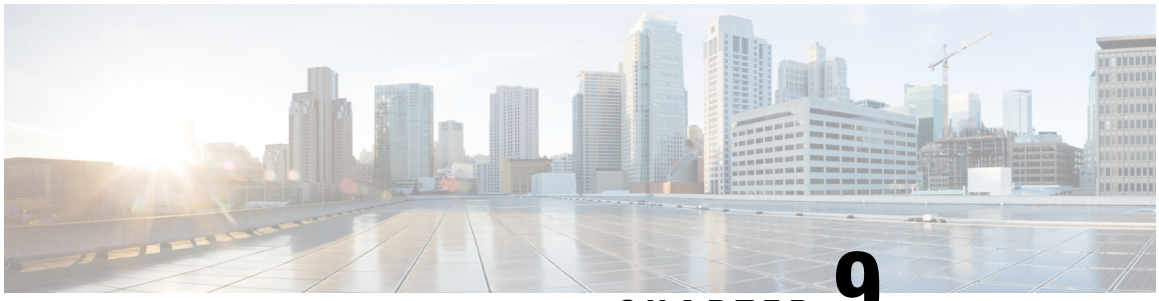
The Priority Flow Control (PFC) functionality is enabed on the console by default. The PFC is also referred to as Class-based Flow Control (CBFC) or Per Priority Pause (PPP) is a mechanism that prevents frame loss

due to congestion. Pressing the `Ctrl + S` keys enables the flow control and no output will be seen on the XR console until resumed.

Solution:

Reset the console prompt.

Press the `Ctrl + Q` keys to resume the console output.



CHAPTER 9

Release-specific Caveats and Workarounds

This section lists the caveats and workarounds when setting up or upgrading the software for each Cisco IOS XR release.

Release 7.10.1

The following upgrade caveats are applicable for Release 7.10.1 and later:

Table 11: Upgrade Caveats

From	To	Bridge SMUs Required	Caveats
7.3.3	7.10.1 and later	Yes	1*, 2*, 3*
7.3.4	7.10.1 and later	Yes	1*, 2*, 3*
7.5.3	7.10.1 and later	None	1*
7.5.4	7.10.1 and later	None	1*
7.7.1	7.10.1 and later	None	1*
7.7.2	7.10.1 and later	None	1*
7.8.1	7.10.1 and later	None	1*
7.8.2	7.10.1 and later	None	1*
7.9.1	7.10.1 and later	None	1*

From	To	Bridge SMUs Required	Caveats
7.9.2	7.10.1 and later	None	1*

1*: You can't roll back using the **install rollback** command.

2*: Ensure that a reload bridging SMU (CSCwd71524) is installed.

3*: Ensure that you install the bridge SMU (CSCwd71524) manually because even if it's available inside the GISO that's replacing the existing GISO, this SMU doesn't get installed automatically.

Note CSCwd71524:

- When you upgrade from earlier than Release 7.10.1 to Release 7.10.1, system supports the installation process seemlessly.
- When you downgrade from Release 7.10.1, system preserves the present configuration and the install history from last transaction.

The following downgrade caveats are applicable for Release 7.10.1 and later:

Table 12: Downgrade Caveats

From	To	Bridge SMUs Required	Caveats
7.10.1 and later	7.3.3	Yes	C*
7.10.1 and later	7.3.4	Yes	C*
7.10.1 and later	7.5.3	Yes	***, A*, B*
7.10.1 and later	7.5.4	Yes	***, A*
7.10.1 and later	7.7.1	Yes	***, A*, B*
7.10.1 and later	7.7.2	Yes	***, A*, B*
7.10.1 and later	7.8.1	Yes	***, A*, B*
7.10.1 and later	7.8.2	Yes	***, A*, B*
7.10.1 and later	7.9.1	Yes	***
7.10.1 and later	7.9.2	Yes	***

***

- You don't need to run the **install commit** command after a downgrade operation because the operation is automatically committed.
- You can't roll back after a downgrade. To revert to the previous IOS XR previous version, replace or reimage to the relevant ISO.

- IOS XR configuration history is lost after a downgrade, but the router preserves the latest configuration.
- Install history from the last transaction is preserved after a downgrade operation.
- Downtime takes a longer time as the operation is performed through reimage.
- You can't downgrade using the **install package replace** command. Instead, use the **install replace** command to downgrade.
- Ensure that you reinstall third-party application once you complete the downgrade.
- PXE recovery is required if the image downgrading isn't bootable.
- You must re-install the *Type 6 masterkey* and reapply the configuration encrypted by it because they are lost after the downgrade.
- You must regenerate crypto keys and certificates after a downgrade.

A*: You can't downgrade to the base ISO. You can downgrade to a GISO containing the bridge SMU (CSCwd71524).

B*: You must recover the router through PXE if a power cycle occurs during the downgrade.

C*: One-step downgrade isn't supported. You must use either PXE/USB to downgrade or perform a two-step downgrade through Release 7.9.1 or Release 7.5.4. The first-hop downgrade to Release 7.9.1 or Release 7.5.4 still carries the same caveats.

Use the **show install upgrade-matrix running** command to view the caveats.

Release 7.9.1

The following caveats are applicable to Release 7.9.1 and later:

- CSCvy66646 (Hitless/Recommended SMU)—When you upgrade from releases earlier than 7.3.2 to release 7.8.2, we recommend that you install the `8000-version-CSCvy66646.tar` SMU from Cisco Software Download center and commit the install operation. Without this SMU, if you upgrade the router and if the router is reloaded due to any issue (excluding **install apply reload** command) before you commit the install operation, the system may prevent install operations in the future.
- CSCvw93597—If the **install package add** *pkg-name* command after **install package replace 8000-x64-7.9.1.iso** command fails when upgrading from release 7.3.15, rerun the **install package add** *pkg-name* command.
- CSCwc47306—The appmgr crashes continuously while downgrading from release 7.8.2 (with the healthcheck optional RPM) to releases earlier than 7.8.2. There is no impact to the upgrade operation.
- CSCwd59323—The counter-size value configured using **healthcheck metric** command is lost when the router is upgraded to release 7.8.2. This size indicates the buffer that stores the history of the counter value. Reconfigure the counter-size to a value in the range of 2 to 15 cadence snapshots.
- CSCwc47212—Configuration on breakout interface is lost after downgrading to releases earlier than 7.8.1 on 8202 router variants. Reapply the configuration.
- CSCwd30936—The `ema_server_sdr` process crashes after downgrading to releases earlier than 7.8.1. There is no workaround and no impact to the functionality.

Release 7.8.2

The following caveats are applicable for Release 7.8.2 and later:

- CSCvy66646 (Hitless/Recommended SMU)—When you upgrade from releases earlier than 7.3.2 to release 7.8.2, we recommend that you install the `8000-version-CSCvy66646.tar` SMU from Cisco Software Download center and commit the install operation. Without this SMU, if you upgrade the router and if the router is reloaded due to any issue (excluding **install apply reload** command) before you commit the install operation, the system may prevent install operations in the future.
- CSCvw93597—If the **install package add** *pkg-name* command after **install package replace 8000-x64-7.8.2.iso** command fails when upgrading from release 7.3.15, rerun the **install package add** *pkg-name* command.
- CSCwc47306—The appmgr crashes continuously while downgrading from release 7.8.2 (with the healthcheck optional RPM) to releases earlier than 7.8.2. There is no impact to the upgrade operation.
- CSCwd59323—The counter-size value configured using **healthcheck metric** command is lost when the router is upgraded to release 7.8.2. This size indicates the buffer that stores the history of the counter value. Reconfigure the counter-size to a value in the range of 2 to 15 cadence snapshots.
- CSCwc47212—Configuration on breakout interface is lost after downgrading to releases earlier than 7.8.2 on 8202 router variants. Reapply the configuration.

Release 7.8.1

The following caveats are applicable for Release 7.8.1 and later:

- CSCvy66646 (Hitless/Recommended SMU)—When you upgrade from releases earlier than 7.3.2 to release 7.8.1, we recommend that you install the `8000-version-CSCvy66646.tar` SMU from Cisco Software Download center and commit the install operation. Without this SMU, if you upgrade the router and if the router is reloaded due to any issue (excluding **install apply reload** command) before you commit the install operation, the system may prevent install operations in the future.
- CSCvw93597—If the **install package add** *pkg-name* command after **install package replace 8000-x64-7.8.1.iso** command fails when upgrading from release 7.3.15, rerun the **install package add** *pkg-name* command.
- CSCwc47306—The appmgr crashes continuously while downgrading from release 7.8.1 (with the healthcheck optional RPM) to releases earlier than 7.7.2. There is no impact to the upgrade operation.
- CSCwd59323—The counter-size value configured using **healthcheck metric** command is lost when the router is upgraded to release 7.8.2. This size indicates the buffer that stores the history of the counter value. Reconfigure the counter-size to a value in the range of 2 to 15 cadence snapshots.
- CSCwb36889—When you upgrade from release 7.3.x to release 7.8.1, the line cards (LCs) may continue to be in the `BOOT HOLD` state, or the BIOS FPD may be in `NEED UPGD` state. This is an intermittent behavior and we recommend that you install the SMU on the 7.3.x image before upgrading to release 7.8.1.
- CSCwd37438—Upgrading from releases earlier than 7.5.1 to 7.8.1 leads to an additional silent reload due to BMC FPGA upgrade. This is specific to only 8201 and 8202 chassis. There is no impact to the upgrade operation. We recommend that you install the RPM before upgrading to release 7.8.1.

Release 7.7.2

The following caveats are applicable for Release 7.7.2 and later:

- CSCvy66646 (Hitless/Recommended SMU)—When you upgrade from releases earlier than 7.3.2 to release 7.7.2, we recommend that you install the `8000-version-CSCvy66646.tar` SMU from Cisco Software Download center and commit the install operation. Without this SMU, if you upgrade the router and if the router is reloaded due to any issue (excluding **install apply reload** command) before you commit the install operation, the system may prevent install operations in the future.
- CSCvw93597—If the **install package add** *pkg-name* command after **install package replace 8000-x64-7.7.2.iso** command fails when upgrading from release 7.3.15, rerun the **install package add** *pkg-name* command.
- CSCwc47306—The appmgr crashes continuously while downgrading from release 7.7.2 (with the healthcheck optional RPM) to releases earlier than 7.7.2. There is no impact to the upgrade operation.
- CSCwb36889—When you upgrade from release 7.3.x to release 7.7.2, the line cards (LCs) may continue to be in the `BOOT HOLD` state, or the BIOS FPD may be in `NEED UPGD` state. This is an intermittent behavior and we recommend that you install the SMU on the 7.3.x image before upgrading to release 7.7.2.
- CSCwd37438—Upgrading from releases earlier than 7.7.2 leads to an additional silent reload due to BMC FPGA upgrade. This is specific to only 8201 and 8202 chassis. There is no impact to the upgrade operation. We recommend that you install the RPM before upgrading to release 7.7.2.

Release 7.7.1

The following upgrade caveats are applicable for Release 7.7.1 and later:

- CSCvy66646 (Hitless/Recommended SMU)—When you upgrade from releases earlier than 7.3.2 to releases 7.7.1, we recommend that you install the `8000-version-CSCvy66646.tar` SMU from Cisco Software Download center and commit the install operation. Without this SMU, if you upgrade the router and if the router is reloaded due to any issue (excluding **install apply reload** command) before you commit the install operation; the system may prevent install operations in the future.
- CSCvw93597—If the **install package add** *pkg-name* command after **install package replace** *iso-image* command fails when upgrading from release 7.3.15, rerun the **install package add** *pkg-name* command.
- CSCvz88814—The upgrade operation fails only in the following scenario:
  1. Upgrade from release 7.3.1 to release 7.7.1
  2. Downgrade from release 7.7.1 to release 7.3.1
  3. Upgrade again to release 7.7.1. The operation fails.

  To avoid the failure when you upgrade after you downgrade the router, run the following commands in order:

  1. **install package remove** *any optional package*
  2. **install package abort all-since-apply**

3. **install replace** *iso-image*

Release 7.5.2, Release 7.5.3

The following caveats are applicable for Release 7.5.2 and Release 7.5.3:

- CSCvy66646 (Hitless/Recommended SMU)—When you upgrade from releases earlier than 7.3.2 to releases 7.5.2 or 7.5.3, we recommend that you install the `8000-version-CSCvy66646.tar` SMU from Cisco Software Download center and commit the install operation. Without this SMU, if you upgrade the router and if the router is reloaded due to any issue (excluding **install apply reload** command) before you commit the install operation; the system may prevent install operations in the future.
- CSCvw93597—If the **install package add** *pkg-name* command after **install package replace** *iso-image* command fails when upgrading from release 7.3.15. To solve the issue, rerun the **install package add** *pkg-name* command.
- CSCvz44123—An error message `ACCESS failure 'fail to get BiosGolden fpd info` displayed on the BIOS does not have a functional impact on the router. After the router is upgraded, the FPD shows the `CURRENT` state.

```
RP/0/RP0/CPU0:Feb 14 21:05:55.720 UTC: fpd_client[251]:
%PLATFORM-CPA_INTF_FPD-3-ACCESS_ERROR : Node
0/RP0/CPU0 FPD BiosGolden ACCESS failure 'fail to get BiosGolden fpd info'
RP/0/RP0/CPU0:Feb 14 21:05:55.738 UTC: fpd_client[251]:
%PLATFORM-CPA_INTF_FPD-3-ACCESS_ERROR : Node
0/RP0/CPU0 FPD Bios ACCESS failure 'fail to get Bios fpd info'
```

- CSCvz88814—The upgrade operation fails only in the following scenario:

  1. Upgrade from release 7.0.14, 7.2.1 or 7.3.1 to release 7.5.2 or 7.5.3
  2. Downgrade from release 7.5.2 or 7.5.3 to release 7.0.14, 7.2.1 or 7.3.1
  3. Upgrade again to release 7.5.2 or 7.5.3. The operation fails.

  To avoid the failure when you upgrade after you downgrade the router, run the following commands in order:

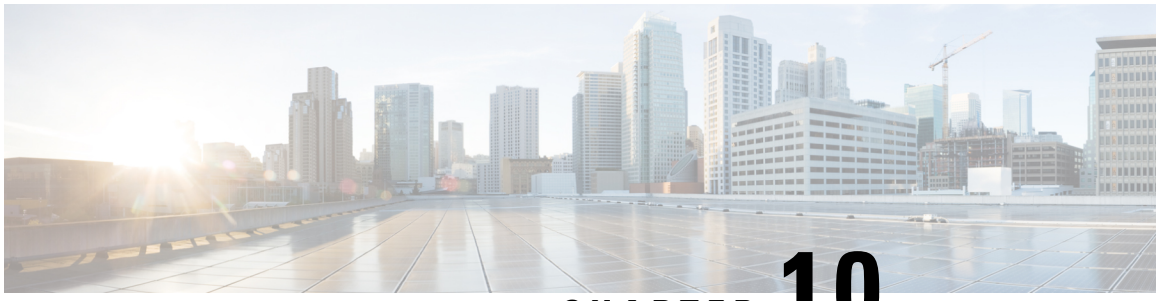
  1. **install package remove** *any optional package*
  2. **install package abort all-since-apply**
  3. **install replace** *iso-image*

Release 7.5.1, Release 7.3.2

The following caveats are applicable for Release 7.5.1 and Release 7.3.2:

- CSCvv17670—The issue with FPDs not upgraded on the line cards in release 7.0.14 with default auto FPD enabled. This issue is resolved in release 7.3.2.
- When auto FPD is enabled, the FPDs are automatically updated when a SMU or image changes, including an updated firmware revision. Although the FPD auto upgrade is enabled by default, when upgrading to

release 7.5.1 or 7.3.2, we recommend that you run the **fpd auto-upgrade enable** command to avoid FPD upgrade failures.



CHAPTER 10

Setup and Upgrade Commands

This section serves as a reference to view the list of commands related to setting up and upgrading the router. Use this section to understand the command syntaxes, default values and sample command usage with output.

Action Commands

- clear configuration inconsistency
- reload
- install add
- install activate (IOS XR 64 bit)
- install deactivate (IOS XR 64 bit)
- install remove
- install replace
- install boot-options
- install commit
- install upgrade source
- ztp enable
- ztp disable
- ztp initiate

Show Commands

- show version
- show platform

- show install
- show install active
- show install committed
- show install inactive
- show install package
- show fpd package
- show hw-module fpd
- show interfaces (frame relay)
- show inventory (Cisco IOS XR 64-bit)
- show ipv4 interface
- show ipv6 interface
- show install boot-options
- show running-config
- show redundancy
- show media