System Management Configuration Guide for Cisco 8000 Series Routers, IOS XR Release 24.1.1

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Preface

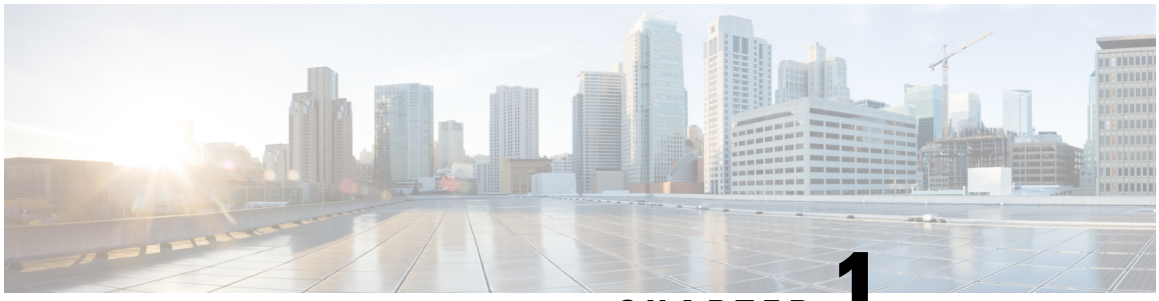
This guide describes the System Management configuration details for Cisco IOS XR software. This chapter contains details on the changes made to this document.

- Changes to this Document, on page xi

Changes to this Document

Table 1: Changes to this Document

Date	Summary
February 2024	Initial release of this document



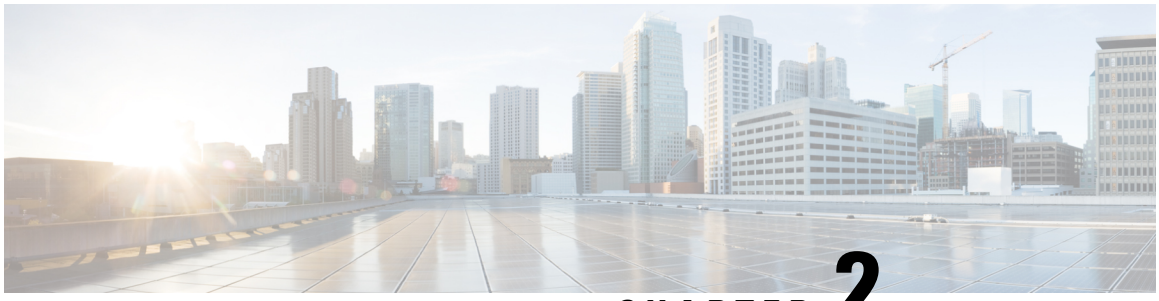
CHAPTER 1

New and Changed System Management Features

This chapter lists all the features that have been added or modified in this guide. The table also contains references to these feature documentation sections.

System Management Features Added or Modified in IOS XR Release 24.1.1

Feature	Description	Changed in Release	Where Documented
Power Redundancy Protection	This feature is introduced.	Release 24.1.1	Power Redundancy Protection , on page 125



CHAPTER 2

YANG Data Models for System Management Features

This chapter provides information about the YANG data models for System Management features.

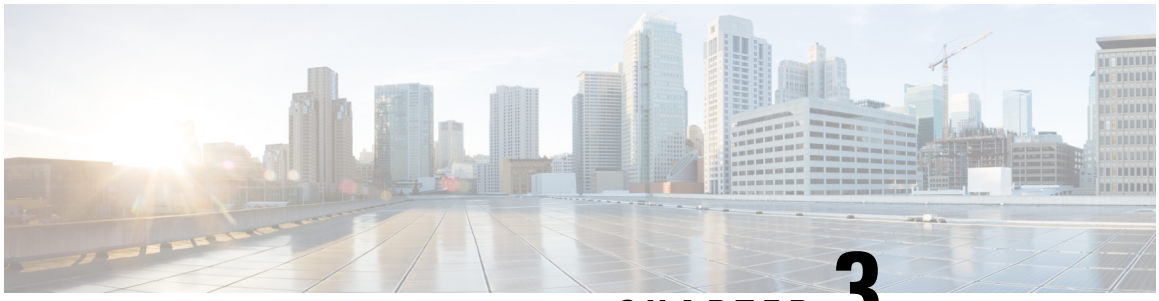
Using YANG Data Models

Cisco IOS XR supports a programmatic way of configuring and collecting operational data of a network device using YANG data models. Although configurations using CLIs are easier and human-readable, automating the configuration using model-driven programmability results in scalability.

The data models are available in the release image, and are also published in the Github repository. Navigate to the release folder of interest to view the list of supported data models and their definitions. Each data model defines a complete and cohesive model, or augments an existing data model with additional XPaths. To view a comprehensive list of the data models supported in a release, navigate to the **Available-Content.md** file in the repository.

You can also view the data model definitions using the YANG Data Models Navigator tool. This GUI-based and easy-to-use tool helps you explore the nuances of the data model and view the dependencies between various containers in the model. You can view the list of models supported across Cisco IOS XR releases and platforms, locate a specific model, view the containers and their respective lists, leaves, and leaf lists presented visually in a tree structure. This visual tree form helps you get insights into nodes that can help you automate your network.

To get started with using the data models, see the *Programmability Configuration Guide*.



CHAPTER 3

Configuring Physical and Virtual Terminals

Line templates define standard attribute settings for incoming and outgoing transport over physical and virtual terminal lines (vtys). Vty pools are used to apply template settings to ranges of vtys.

This module describes the tasks you need to implement physical and virtual terminals on your Cisco IOS XR network.

Prerequisites for Implementing Physical and Virtual Terminals

You must be in a user group associated with a task group that includes the proper task IDs. The command reference guides include the task IDs required for each command. If you suspect user group assignment is preventing you from using a command, contact your AAA administrator for assistance.

Information About Implementing Physical and Virtual Terminals

To implement physical and virtual terminals, you need to understand the concepts in this section.

Tip You can programmatically manage the physical and virtual terminals using `openconfig-system-terminal.yang` OpenConfig data model. To get started with using data models, see the *Programmability Configuration Guide for Cisco 8000 Series Routers*.

Line Templates

The following line templates are available in the Cisco IOS XR software.

- Default line template—The default line template that applies to a physical and virtual terminal lines.
- Console line template—The line template that applies to the console line.

- User-defined line templates—User-defined line templates that can be applied to a range of virtual terminal lines.

Line Template Configuration Mode

Changes to line template attributes are made in line template configuration mode. To enter line template configuration mode, issue the **line** command from XR Config mode, specifying the template to be modified. These line templates can be configured with the **line** command:

- console—console template
- default—default template
- template—user-defined template

After you specify a template with the **line** command, the router enters line template configuration mode where you can set the terminal attributes for the specified line. This example shows how to specify the attributes for the console:

```
RP/0/RP0/CPU0:router(config)# line console
RP/0/RP0/CPU0:router(config-line)#
```

From line template configuration mode, use the online help feature (**?**) to view all available options. Some useful options include:

- absolute-timeout—Specifies a timeout value for line disconnection.
- escape-character—Changes the line escape character.
- exec-timeout—Specifies the EXEC timeout.
- length—Sets the number of lines displayed on the screen.
- session-limit—Specifies the allowable number of outgoing connections.
- session-timeout—Specifies an interval for closing the connection if there is no input traffic.
- timestamp—Displays the timestamp before each command.
- width—Specifies the width of the display terminal.

Note The *default* session-limit for line template is applicable to Telnet sessions only. It is not applicable for SSH sessions.

Line Template Guidelines

The following guidelines apply to modifying the console template and to configuring a user-defined template:

- Modify the templates for the physical terminal lines on the router (the console port) from line template configuration mode. Use the **line console** command from XR Config mode to enter line template configuration mode for the console template.

- Modify the template for virtual lines by configuring a user-defined template with the **line** *template-name* command, configuring the terminal attributes for the user-defined template from line template configuration, and applying the template to a range of virtual terminal lines using the **vty pool** command.

Attributes not defined in the console template, or any virtual template, are taken from the default template.

The default settings for the default template are described for all commands in line template configuration mode in the *Terminal Services Commands on* module in *System Management Command Reference for Cisco 8000 Series Routers*.

Note Before creating or modifying the vty pools, enable the telnet server using the **telnet server** command in XR Config mode. See *IP Addresses and Services Configuration Guide for Cisco 8000 Series Routers* and *IP Addresses and Services Command Reference for Cisco 8000 Series Routers* for more information.

Terminal Identification

The physical terminal lines for the console port is identified by its location, expressed in the format of *rack*/*slot*/*module* , on the active or standby route processor (RP) where the respective console port resides. For virtual terminals, physical location is not applicable; the Cisco IOS XR software assigns a vty identifier to vtys according to the order in which the vty connection has been established.

vty Pools

Each virtual line is a member of a pool of connections using a common line template configuration. Multiple vty pools may exist, each containing a defined number of vtys as configured in the vty pool. The Cisco IOS XR software supports the following vty pools by default:

- Default vty pool—The default vty pool consists of five vtys (vtys 0 through 4) that each reference the default line template.
- Default fault manager pool—The default fault manager pool consists of six vtys (vtys 100 through 105) that each reference the default line template.

In addition to the default vty pool and default fault manager pool, you can also configure a user-defined vty pool that can reference the default template or a user-defined template.

When configuring vty pools, follow these guidelines:

- The vty range for the default vty pool must start at vty 0 and must contain a minimum of five vtys.
- The vty range from 0 through 99 can reference the default vty pool.
- The vty range from 5 through 99 can reference a user-defined vty pool.
- The vty range from 100 is reserved for the fault manager vty pool.
- The vty range for fault manager vty pools must start at vty 100 and must contain a minimum of six vtys.
- A vty can be a member of only one vty pool. A vty pool configuration will fail if the vty pool includes a vty that is already in another pool.
- If you attempt to remove an active vty from the active vty pool when configuring a vty pool, the configuration for that vty pool will fail.

How to Implement Physical and Virtual Terminals on Cisco IOS XR Software

Modifying Templates

This task explains how to modify the terminal attributes for the console and default line templates. The terminal attributes that you set will modify the template settings for the specified template.

SUMMARY STEPS

1. **configure**
2. **line** {**console** | **default**}
3. Configure the terminal attribute settings for the specified template using the commands in line template configuration mode.
4. Use one of the following commands:
   - **end**
   - **commit**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure** **Example:** `RP/0/RP0/CPU0:router# configure`	Enters mode.

Step 2	**line** {**console**	**default**}
		Example:
		`RP/0/RP0/CPU0:router(config)# line console`
		or
		`RP/0/RP0/CPU0:router(config)# line default`
			Enters line template configuration mode for the specified line template.
			• **console** —Enters line template configuration mode for the console template.
			• **default** —Enters line template configuration mode for the default line template.

Step 3	Configure the terminal attribute settings for the specified template using the commands in line template configuration mode.	—
Step 4	Use one of the following commands: • **end** • **commit** **Example:** `RP/0/RP0/CPU0:router(config-line)# end`	Saves configuration changes. • When you issue the **end** command, the system prompts you to commit changes: `Uncommitted changes found, commit them before exiting(yes/no/cancel)? [cancel]:`

	Command or Action	Purpose
	or `RP/0/RP0/CPU0:router(config-line)# commit`	• Entering **yes** saves configuration changes to the running configuration file, exits the configuration session, and returns the router to EXEC mode. • Entering **no** exits the configuration session and returns the router to EXEC mode without committing the configuration changes. • Entering **cancel** leaves the router in the current configuration session without exiting or committing the configuration changes. • Use the **commit** command to save the configuration changes to the running configuration file and remain within the configuration session.

Creating and Modifying vty Pools

This task explains how to create and modify vty pools.

SUMMARY STEPS

1. **configure**
2. **telnet** {**ipv4** | **ipv6**} **server max-servers** *limit*
3. **line template** *template-name*
4. Configure the terminal attribute settings for the specified line template using the commands in line template configuration mode.
5. **exit**
6. **vty-pool** {**default** | *pool-name* | **eem**} *first-vty last-vty* [**line-template** {**default** | *template-name*}]
7. Use the **commit** or **end** command.

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure** **Example:** `RP/0/RP0/CPU0:router# configure`	Enters mode.
Step 2	**telnet** {**ipv4**	**ipv6**} **server max-servers** *limit* **Example:** `RP/0/RP0/CPU0:router(config)# telnet ipv4 server max-servers 10`	Specifies the number of allowable Telnet servers. Up to 100 Telnet servers are allowed. **Note** By default no Telnet servers are allowed. You must configure this command in order to enable the use of Telnet servers.

	Command or Action	Purpose
Step 3	**line template** *template-name* **Example:** `RP/0/RP0/CPU0:router(config)# line template 1`	Enters line template configuration mode for a user-defined template.
Step 4	Configure the terminal attribute settings for the specified line template using the commands in line template configuration mode.	—
Step 5	**exit** **Example:** `RP/0/RP0/CPU0:router(config-line)# exit`	Exits line template configuration mode and returns the router to global configuration mode.

Step 6	**vty-pool** {**default** | *pool-name* | **eem**} *first-vty last-vty* [**line-template** {**default** | *template-name*}]
	Example:
	`RP/0/RP0/CPU0:router(config)# vty-pool default 0 5 line-template default`
	or
	`RP/0/RP0/CPU0:router(config)# vty-pool pool1 5 50 line-template template1`
	or
	`RP/0/RP0/CPU0:router(config)# vty-pool eem 100 105 line-template template1`
		Creates or modifies vty pools.
		• If you do not specify a line template with the **line-template** keyword, a vty pool defaults to the default line template.
		• **default** —Configures the default vty pool.
		  • The default vty pool must start at vty 0 and must contain a minimum of five vtys (vtys 0 through 4).
		  • You can resize the default vty pool by increasing the range of vtys that compose the default vty pool.
		• *pool-name* —Creates a user-defined vty pool.
		  • A user-defined pool must start at least at vty 5, depending on whether the default vty pool has been resized.
		  • If the range of vtys for the default vty pool has been resized, use the first range value free from the default line template. For example, if the range of vtys for the default vty pool has been configured to include 10 vtys (vty 0 through 9), the range value for the user-defined vty pool must start with vty 10.
		• **eem** —Configures the embedded event manager pool.
		  • The default embedded event manager vty pool must start at vty 100 and must contain a minimum of six vtys (vtys 100 through 105).

	Command or Action	Purpose
		• **line-template** *template-name* —Configures the vty pool to reference a user-defined template.
Step 7	Use the **commit** or **end** command.	**commit** —Saves the configuration changes and remains within the configuration session. **end** —Prompts user to take one of these actions: • **Yes** — Saves configuration changes and exits the configuration session. • **No** —Exits the configuration session without committing the configuration changes. • **Cancel** —Remains in the configuration session, without committing the configuration changes.

Monitoring Terminals and Terminal Sessions

This task explains how to monitor terminals and terminal sessions using the **show** EXEC commands available for physical and terminal lines.

Note The commands can be entered in any order.

SUMMARY STEPS

1. (Optional) **show line** [**aux location** *node-id* | **console location** *node-id* | **vty** *number*]
2. (Optional) **show terminal**
3. (Optional) **show users**

DETAILED STEPS

	Command or Action	Purpose
Step 1	(Optional) **show line** [**aux location** *node-id* | **console location** *node-id* | **vty** *number*] **Example:** `RP/0/RP0/CPU0:router# show line`	Displays the terminal parameters of terminal lines. • Specifying the **show line aux location** *node-id* EXEC command displays the terminal parameters of the auxiliary line. • Specifying the **show line console location** *node-id* EXEC command displays the terminal parameters of the console. • For the **location** *node-id* keyword and argument, enter the location of the Route Processor (RP) on which the respective auxiliary or console port resides.

	Command or Action	Purpose
		• The *node-id* argument is expressed in the format of *rack*/*slot*/*module* . • Specifying the **show line vty** *number* EXEC command displays the terminal parameters for the specified vty.
Step 2	(Optional) **show terminal** **Example:** `RP/0/RP0/CPU0:router# show terminal`	Displays the terminal attribute settings for the current terminal line.
Step 3	(Optional) **show users** **Example:** `RP/0/RP0/CPU0:router# show users`	Displays information about the active lines on the router.

Configuration Examples for Implementing Physical and Virtual Terminals

Modifying the Console Template: Example

This configuration example shows how to modify the terminal attribute settings for the console line template:

```
line console
  exec-timeout 0 0
  escape-character 0x5a
  session-limit 10
  disconnect-character 0x59
  session-timeout 100
  transport input telnet
  transport output telnet
```

In this configuration example, the following terminal attributes are applied to the console line template:

- The EXEC time out for terminal sessions is set to 0 minutes, 0 seconds. Setting the EXEC timeout to 0 minutes and 0 seconds disables the EXEC timeout function; thus, the EXEC session for the terminal session will never time out.
- The escape character is set to the 0x5a hexadecimal value (the 0x5a hexadecimal value translates into the “Z” character).
- The session limit for outgoing terminal sessions is set to 10 connections.
- The disconnect character is set to 0x59 hexadecimal value (the 0x59 hexadecimal character translates into the “Y” character).

- The session time out for outgoing terminal sessions is set to 100 minutes (1 hour and 40 minutes).
- The allowed transport protocol for incoming terminal sessions is Telnet.
- The allowed transport protocol for outgoing terminal sessions is Telnet.

To verify that the terminal attributes for the console line template have been applied to the console, use the **show line** command:

```
RP/0/RP0/CPU0:router# show line console location 0/0/CPU0

Tty             Speed     Modem  Uses   Noise Overruns           Acc I/O
*  con0/0/CPU0      9600        -     -       -      0/0               -/-

Line con0_0_CPU0, Location "Unknown", Type "Unknown"
Length: 24 lines, Width: 80 columns
Baud rate (TX/RX) is 9600, 1 parity, 2 stopbits, 8 databits
Template: console
Config:
Allowed transports are telnet.
```

Modifying the Default Template: Example

This configuration example shows how to override the terminal settings for the default line template:

```
line default
  exec-timeout 0 0
  width 512
  length 512
```

In this example, the following terminal attributes override the default line template default terminal attribute settings:

- The EXEC timeout for terminal sessions is set to 0 minutes and 0 seconds. Setting the EXEC timeout to 0 minutes and 0 seconds disables the EXEC timeout function; thus, the EXEC session for the terminal session will never time out (the default EXEC timeout for the default line template is 10 minutes).
- The width of the terminal screen for the terminals referencing the default template is set to 512 characters (the default width for the default line template is 80 characters).
- The length, the number of lines that will display at one time on the terminal referencing the default template, is set to 512 lines (the default length for the default line template is 24 lines).

Configuring a User-Defined Template to Reference the Default vty Pool: Example

This configuration example shows how to configure a user-defined line template (named test in this example) for vtys and to configure the line template test to reference the default vty pool:

```
line template test
  exec-timeout 100 0
  width 100
  length 100
```

```
  exit
vty-pool default 0 4 line-template test
```

Configuring a User-Defined Template to Reference a User-Defined vty Pool: Example

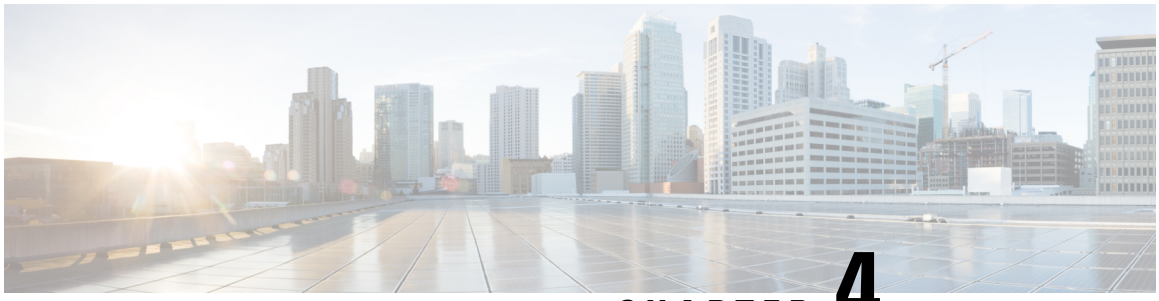
This configuration example shows how to configure a user-defined line template (named test2 in this example) for vtys and to configure the line template test to reference a user-defined vty pool (named pool1 in this example):

```
line template test2
  exec-timeout 0 0
  session-limit 10
  session-timeout 100
  transport input all
  transport output all
  exit
vty-pool pool1 5 50 line-template test2
```

Configuring a User-Defined Template to Reference the Fault Manager vty Pool: Example

This configuration example shows how to configure a user-defined line template (named test3 in this example) for vtys and to configure the line template test to reference the fault manager vty pool:

```
line template test3
  width 110
  length 100
  session-timeout 100
  exit
  vty-pool eem 100 106 line-template test3
```



CHAPTER 4

Configuring Simple Network Management Protocol

Simple Network Management Protocol (SNMP) is an application-layer protocol that provides a message format for communication between SNMP managers and agents. SNMP provides a standardized framework and a common language used for the monitoring and management of devices in a network.

This module describes the tasks you need to implement SNMP on your Cisco IOS XR network.

Prerequisites for Implementing SNMP

You must be in a user group associated with a task group that includes the proper task IDs. The command reference guides include the task IDs required for each command. If you suspect user group assignment is preventing you from using a command, contact your AAA administrator for assistance.

Restrictions for SNMP use on Cisco IOS XR Software

SNMP outputs are only 32-bits wide and therefore cannot display any information greater than 2^{32}. 2^{32} is equal to 4.29 Gigabits.

Note A10 Gigabit interface is greater than 2^{32}, so if you are trying to display speed information regarding the interface, you might see concatenated results.

To display correct speed of an interface greater than 10 Gigabit, ifHighSpeed can be used.

The recommended maximum number of object identifiers (OIDs) that can be accommodated in a single SNMP request is 75. A request with more than 75 OIDs can result in SNMP requests being dropped with SNMP polling timeout.

Information about Implementing SNMP

To implement SNMP, you need to understand the concepts described in this section.

SNMP Functional Overview

The SNMP framework consists of three parts:

- SNMP manager
- SNMP agent
- Management Information Base (MIB)

SNMP Manager

The SNMP manager is the system used to control and monitor the activities of network hosts using SNMP. The most common managing system is called a *network management system* (NMS). The term NMS can be applied to either a dedicated device used for network management, or the applications used on such a device. A variety of network management applications are available for use with SNMP. These features range from simple command-line applications to feature-rich graphical user interfaces (such as the CiscoWorks 2000 line of products).

SNMP Agent

The SNMP agent is the software component within the managed device that maintains the data for the device and reports these data, as needed, to managing systems. The agent and MIB reside on the router. To enable the SNMP agent, you must define the relationship between the manager and the agent.

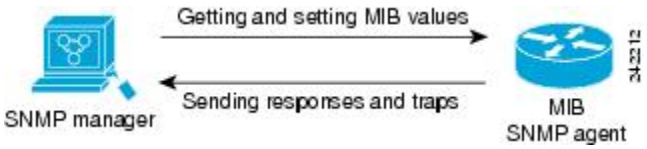
MIB

The *Management Information Base* (MIB) is a virtual information storage area for network management information, which consists of collections of managed objects. Within the MIB there are collections of related objects, defined in MIB modules. MIB modules are written in the SNMP MIB module language, as defined in STD 58, RFC 2578, RFC 2579, and RFC 2580. Note that individual MIB modules are also referred to as MIBs; for example, the Interfaces Group MIB (IF-MIB) is a MIB module within the MIB on your system.

The SNMP agent contains MIB variables whose values the SNMP manager can request or change through Get or Set operations. A manager can get a value from an agent or store a value into that agent. The agent gathers data from the MIB, the repository for information about device parameters and network data. The agent can also respond to manager requests to get or set data.

This figure illustrates the communications relationship between the SNMP manager and agent. A manager can send the agent requests to get and set MIB values. The agent can respond to these requests. Independent of this interaction, the agent can send unsolicited notifications (traps) to the manager to notify the manager of network conditions.

Figure 1: Communication Between an SNMP Agent and Manager



IP-MIB Support

RFC4293 IP-MIB was specifically designed to provide IPv4 and IPv6 statistics individually. The **ipIfStatsTable** defined in RFC 4293, lists the interface specific statistics. IPv6 statistics support in ipIfStatsTable was added earlier but, IOS-XR implementation of IP-MIB did not support IPv4 statistics as per RFC4293 in earlier releases.

IOS-XR implementation of IP-MIB supports IPv4 statistics as per RFC4293. This will enable you to collect the IPV4 and IPv6 statistics separately for each interface. The **ipIfStatsTable** is indexed by two **sub-ids address type (IPv4 or IPv6)** and the **interface ifindex[1]**. The implementation of IP-MIB support for IPv4 and IPv6 is separated for better readability and maintainability.

The list of OIDs added to the **ipIfStatsTable** for IPv4 statistics are:

- ipIfStatsInReceives
- ipIfStatsHCInReceives
- ipIfStatsInOctets
- ipIfStatsHCInOctets
- ipIfStatsOutTransmits
- ipIfStatsHCOutTransmits
- ipIfStatsOutOctets
- ipIfStatsHCOutOctets
- ipIfStatsDiscontinuityTime

For more information on the list of new OIDs added for iPv4 statistics, see SNMP OID Navigator.

SNMP Versions

Cisco IOS XR software supports the following versions of SNMP:

- Simple Network Management Protocol Version 1 (SNMPv1)
- Simple Network Management Protocol Version 2c (SNMPv2c)
- Simple Network Management Protocol Version 3 (SNMPv3)

Both SNMPv1 and SNMPv2c use a community-based form of security. The community of managers able to access the agent MIB is defined by an IP address access control list and password.

SNMPv2c support includes a bulk retrieval mechanism and more detailed error message reporting to management stations. The bulk retrieval mechanism supports the retrieval of tables and large quantities of information, minimizing the number of round-trips required. The SNMPv2c improved error handling support

includes expanded error codes that distinguish different kinds of error conditions; these conditions are reported through a single error code in SNMPv1. Error return codes now report the error type. Three kinds of exceptions are also reported: no such object exceptions, no such instance exceptions, and end of MIB view exceptions.

SNMPv3 is a security model. A *security model* is an authentication strategy that is set up for a user and the group in which the user resides. A *security level* is the permitted level of security within a security model. A combination of a security model and a security level will determine which security mechanism is employed when an SNMP packet is handled. See Security Models and Levels for SNMPv1, v2, v3, on page 19 for a list of security levels available in SNMPv3. The SNMPv3 feature supports RFCs 3411 to 3418.

You must configure the SNMP agent to use the version of SNMP supported by the management station. An agent can communicate with multiple managers; for this reason, you can configure the Cisco IOS-XR software to support communications with one management station using the SNMPv1 protocol, one using the SNMPv2c protocol, and another using SMNPv3.

Comparison of SNMPv1, v2c, and v3

SNMP v1, v2c, and v3 all support the following operations:

- get-request—Retrieves a value from a specific variable.
- get-next-request—Retrieves the value following the named variable; this operation is often used to retrieve variables from within a table. With this operation, an SNMP manager does not need to know the exact variable name. The SNMP manager searches sequentially to find the needed variable from within the MIB.
- get-response—Operation that replies to a get-request, get-next-request, and set-request sent by an NMS.
- set-request—Operation that stores a value in a specific variable.
- trap—Unsolicited message sent by an SNMP agent to an SNMP manager when some event has occurred.

This table identifies other key SNMP features supported by the SNMP v1, v2c, and v3.

Table 2: SNMPv1, v2c, and v3 Feature Support

Feature	SNMP v1	SNMP v2c	SNMP v3
Get-Bulk Operation	No	Yes	Yes
Inform Operation	No	Yes	Yes
64 Bit Counter	No	Yes	Yes
Textual Conventions	No	Yes	Yes
Authentication	No	No	Yes
Privacy (Encryption)	No	No	Yes
Authorization and Access Controls (Views)	No	No	Yes

Security Models and Levels for SNMPv1, v2, v3

The security level determines if an SNMP message needs to be protected from disclosure and if the message needs to be authenticated. The various security levels that exist within a security model are as follows:

- noAuthNoPriv—Security level that does not provide authentication or encryption.
- authNoPriv—Security level that provides authentication but does not provide encryption.
- authPriv—Security level that provides both authentication and encryption.

Three security models are available: SNMPv1, SNMPv2c, and SNMPv3. The security model combined with the security level determine the security mechanism applied when the SNMP message is processed.

The below table identifies what the combinations of security models and levels mean.

Table 3: SNMP Security Models and Levels

Model	Level	Authentication	Encryption	What Happens
v1	noAuthNoPriv	Community string	No	Uses a community string match for authentication.
v2c	noAuthNoPriv	Community string	No	Uses a community string match for authentication.
v3	noAuthNoPriv	Username	No	Uses a username match for authentication.
v3	authNoPriv	HMAC-MD5 or HMAC-SHA	No	Provides authentication based on the HMAC[1]-MD5[2] algorithm or the HMAC-SHA[3].
v3	authPriv	HMAC-MD5 or HMAC-SHA	DES	Provides authentication based on the HMAC-MD5 or HMAC-SHA algorithms. Provides DES[4] 56-bit encryption in addition to authentication based on the CBC[5] DES (DES-56) standard.
v3	authPriv	HMAC-MD5 or HMAC-SHA	3DES	Provides authentication based on the HMAC-MD5 or HMAC-SHA algorithms. Provides 168-bit 3DES[6] level of encryption.
v3	authPriv	HMAC-MD5 or HMAC-SHA	AES	Provides authentication based on the HMAC-MD5 or HMAC-SHA algorithms. Provides 128-bit AES[7] level of encryption.

1 Hash-Based Message Authentication Code
2 Message Digest 5
3 Secure Hash Algorithm
4 Data Encryption Standard
5 Cipher Block Chaining
6 Triple Data Encryption Standard
7 Advanced Encryption Standard

Use of 3DES and AES encryption standards requires that the security package be installed. For information on installing software packages, see *Upgrading and Managing Cisco IOS XR Software*.

SNMPv3 Benefits

SNMPv3 provides secure access to devices by providing authentication, encryption and access control. These added security benefits secure SNMP against the following security threats:

- Masquerade—The threat that an SNMP user may assume the identity of another SNMP user to perform management operations for which that SNMP user does not have authorization.
- Message stream modification—The threat that messages may be maliciously reordered, delayed, or replayed (to an extent that is greater than can occur through the natural operation of a subnetwork service) to cause SNMP to perform unauthorized management operations.
- Disclosure—The threat that exchanges between SNMP engines could be eavesdropped. Protecting against this threat may be required as a matter of local policy.

In addition, SNMPv3 provides access control over protocol operations on SNMP managed objects.

SNMPv3 Costs

SNMPv3 authentication and encryption contribute to a slight increase in the response time when SNMP operations on MIB objects are performed. This cost is far outweighed by the security advantages provided by SNMPv3.

This table shows the order of response time (from least to greatest) for the various security model and security level combinations.

Table 4: Order of Response Times from Least to Greatest

Security Model	Security Level
SNMPv2c	noAuthNoPriv
SNMPv3	noAuthNoPriv
SNMPv3	authNoPriv
SNMPv3	authPriv

User-Based Security Model

SNMPv3 User-Based Security Model (USM) refers to SNMP message-level security and offers the following services:

- Message integrity—Ensures that messages have not been altered or destroyed in an unauthorized manner and that data sequences have not been altered to an extent greater than can occur nonmaliciously.
- Message origin authentication—Ensures that the claimed identity of the user on whose behalf received data was originated is confirmed.
- Message confidentiality—Ensures that information is not made available or disclosed to unauthorized individuals, entities, or processes.

SNMPv3 authorizes management operations only by configured users and encrypts SNMP messages.

USM uses two authentication protocols:

- HMAC-MD5-96 authentication protocol
- HMAC-SHA-96 authentication protocol

USM uses Cipher Block Chaining (CBC)-DES (DES-56) as the privacy protocol for message encryption.

View-Based Access Control Model

The View-Based Access Control Model (VACM) enables SNMP users to control access to SNMP managed objects by supplying read, write, or notify access to SNMP objects. It prevents access to objects restricted by views. These access policies can be set when user groups are configured with the **snmp-server group** command.

MIB Views

For security reasons, it is often valuable to be able to restrict the access rights of some groups to only a subset of the management information within the management domain. To provide this capability, access to a management object is controlled through MIB views, which contain the set of managed object types (and, optionally, the specific instances of object types) that can be viewed.

Access Policy

Access policy determines the access rights of a group. The three types of access rights are as follows:

- read-view access—The set of object instances authorized for the group when objects are read.
- write-view access—The set of object instances authorized for the group when objects are written.
- notify-view access—The set of object instances authorized for the group when objects are sent in a notification.

IP Precedence and DSCP Support for SNMP

SNMP IP Precedence and differentiated services code point (DSCP) support delivers QoS specifically for SNMP traffic. You can change the priority setting so that SNMP traffic generated in a router is assigned a specific QoS class. The IP Precedence or IP DSCP code point value is used to determine how packets are handled in weighted random early detection (WRED).

After the IP Precedence or DSCP is set for the SNMP traffic generated in a router, different QoS classes cannot be assigned to different types of SNMP traffic in that router.

The IP Precedence value is the first three bits in the type of service (ToS) byte of an IP header. The IP DSCP code point value is the first six bits of the differentiate services (DiffServ Field) byte. You can configure up to eight different IP Precedence markings or 64 different IP DSCP markings.

Custom MIB Support Using SNMP Operation Script

Table 5: Feature History Table

Feature Name	Release Information	Feature Description
Custom MIB Support Using SNMP Operations Script	Release 7.5.3	Now you don't have to upgrade to the latest Cisco IOS XR Software release to access a new Management Information Base (MIB). This feature allows you to add a custom script to get support for custom MIB that is not implemented on Cisco IOS XR Software. Custom MIB fetches the required data from an operational database that is already available on the router and returns it on polling the Object Identifier (OID). This feature introduces the following commands: • snmp-server script • script snmp This feature also adds the following unified models, you can access these unified models in the Github repository. • Cisco-IOS-XR-um-script-cfg • Cisco-IOS-XR-um-script-server-cfg

The MIB is a virtual information storage area for network management information, which consists of collections of managed objects. The OID acts as an identifier to fetch the required data from MIB.

This feature introduces support for custom MIBs that are not implemented in Cisco IOS XR Software. Typically, developing a new MIB is a long and tedious process. Also, you must upgrade to a particular release to get the support of the new MIB.

With this feature, you can define a custom script for a given OID. This custom OID gets the data in the operational database already present on the router and returns it on polling the newly configured OID. SNMP request is sent from Network Management System (NMS) over User Datagram Protocol (UDP) to SNMP daemon. This request spawns customer scripts to fetch data that is related to OID in the request and the output of the script is converted to SNMP protocol data unit and sent to NMS.

Prerequisites

- In the script, the Cython API snmp_send_response should be called with data of OID.

Restrictions for Custom MIB

- The length of string data type OIDs must not cross 400 bytes.

Create Custom MIB Using SNMP Script

Configuration Example

In the below example, we create a script which creates OID 1.3.6.1.4.1.9.9.999998.10 to read lldp state.

1. Create a script to fetch required data from the operational database on the router.
2. Use the **describe** command, to fetch the process which executes the command,.

```
Router#describe show lldp
The command is defined in lldp_cmds.parser

User needs ALL of the following taskids:

 ethernet-services (READ) or optical (READ)

It will take the following actions:
  Spawn the process:
    lldp_command "-s" "-g"
```

The output **lldp_command "-s" "-g"** is used in the following script.

Here is a sample script named **show_lldp_string.py**. This is the command syntax used in the script.

```
import iosxr.snmp
import time
import subprocess as sp
import re
oid = iosxr.snmp.snmp_get_oid()
access_type = iosxr.snmp.snmp_get_access_type()
value = sp.getoutput("lldp_command \"-s\" \"-g\"" )
iosxr.snmp.snmp_send_response("1.3.6.1.4.1.9.9.999998.10", str(value), "OctetString")
```

3. Copy the script file to this location: harddisk:/mirror/script-mgmt/snmp/.
4. Use the **sha256sum** *file-name* command to generate the checksum of the script file.

```
Router:/harddisk:/mirror/script-mgmt/snmp]$sha256sum show_lldp_string.py
```

Here is a sample command output.

```
156345c2cbfc1a2725b5f5ecdfb23d30d9a25e894604890d88929d724946e7b3 show_lldp_string.py
```

5. Enter the configuration mode of the router.

```
Router#configure
```

6. Use the **snmp-server community public RW** command to enable read-write community string, where public is the read-write community.

```
Router(config)#snmp-server community public RW
```

7. Use the **snmp-server script script-oid** *OID-number* **script-filename** *file-name* command to map the script file to the custom OID.

```
Router(config)#snmp-server script script-oid 1.3.6.1.4.1.9.9.999998.10 script-filename
show_lldp_string.py
```

8. Use the **script snmp** *file-name* **checksum sha256** *checksum-value* command to configure the checksum of the script file.

```
Router(config)#script snmp show_lldp_string.py checksum sha256
156345c2cbfc1a2725b5f5ecdfb23d30d9a25e894604890d88929d724946e7b3
```

Note

- The root OID number 1.3.6.1.4.1.9.9.999998 must be used and you can write any Custom OID number after the root OID number.

Yang Data Model for Custom MIB

You can programmatically perform the same configuration using the following unified data models also. To get started with using data models, see the *Programmability Configuration Guide for Cisco 8000 Series Routers*.

Operational Data	Unified Data Model	CLI Commands
Maps script file to the custom OID.	Cisco-IOS-XR-um-script-server-cfg	**snmp-server script script-oid** *OID-number* **script-filename** *file-name*
Configures checksum for the newly added file-name in the Custom OID.	Cisco-IOS-XR-um-script-cfg	**script snmp** *file-name* **checksum sha256** *checksum-value*

Verification

When snmp receives get request for the custom OID, following output is generated:

```
Router # snmpwalk -v2c -c public 5.36.7.100 1.3.6.1.4.1.9.9.999998.10
SNMPv2-SMI::enterprises.9.9.999998.10.0 = STRING: Global LLDP information:
        Status: ACTIVE
        LLDP Chassis ID: 0032.176e.a0df
        LLDP Chassis ID Subtype: MAC Address (IEEE 802-2001) Chassis Subtype
        LLDP System Name: POD-TN3
        LLDP advertisements are sent every 30 seconds
        LLDP hold time advertised is 120 seconds
        LLDP interface reinitialisation delay is 2 seconds
```

Session MIB support on subscriber sessions

SNMP monitoring requires information about subscribers of all types. The CISCO-SUBSCRIBER-SESSION-MIB is defined to model per-subscriber data as well as aggregate subscriber (PPPoE) data. It is required to support notifications (traps) for aggregate session counts crossing configured thresholds. Generic MIB Data Collector Manager (DCM) support for CISCO-SUBSCRIBER-SESSION-MIB, helps faster data collection and also better handling of parallel data.

SNMP Notifications

A key feature of SNMP is the ability to generate notifications from an SNMP agent. These notifications do not require that requests be sent from the SNMP manager. On Cisco IOS XR software, unsolicited (asynchronous) notifications can be generated only as *traps*. Traps are messages alerting the SNMP manager to a condition on the network. Notifications can indicate improper user authentication, restarts, the closing of a connection, loss of connection to a neighbor router, or other significant events.

Note Inform requests (inform operations) are supported in Cisco IOS XR software.

Traps are less reliable than informs because the receiver does not send any acknowledgment when it receives a trap. The sender cannot determine if the trap was received. An SNMP manager that receives an inform request acknowledges the message with an SNMP response protocol data unit (PDU). If the manager does not receive an inform request, it does not send a response. If the sender never receives a response, the inform request can be sent again. Thus, informs are more likely to reach their intended destination.

However, traps are often preferred because informs consume more resources in the router and in the network. Unlike a trap, which is discarded as soon as it is sent, an inform request must be held in memory until a response is received or the request times out. Also, traps are sent only once, and an inform may be retried several times. The retries increase traffic and contribute to a higher overhead on the network. Thus, traps and inform requests provide a trade-off between reliability and resources.

Figure 2: Trap Received by the SNMP Manager

In this illustration, the agent router sends a trap to the SNMP manager. Although the manager receives the trap, it does not send any acknowledgment to the agent. The agent has no way of knowing that the trap reached its destination.

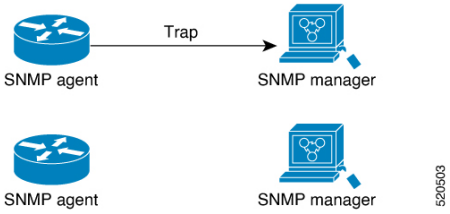
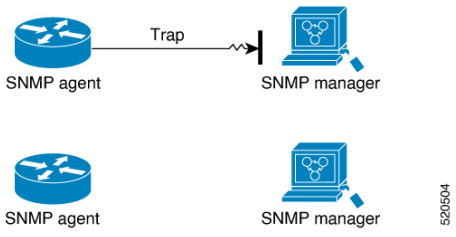


Figure 3: Trap Not Received by the SNMP Manager

In this illustration, the agent sends a trap to the manager, but the trap does not reach the manager. Because the agent has no way of knowing that the trap did not reach its destination, the trap is not sent again. The manager never receives the trap.



Session Types

The supported session types are:

- PPPoE

- IP SUB PKT
- IP SUB DHCP

How to Implement SNMP on Cisco IOS XR Software

This section describes how to implement SNMP.

The **snmp-server** commands enable SNMP on Management Ethernet interfaces by default. For information on how to enable SNMP server support on other inband interfaces, see the *Implementing Management Plane Protection on Cisco IOS XR Software* module in *System Security Configuration Guide for Cisco 8000 Series Routers*.

Configuring SNMPv3

This task explains how to configure SNMPv3 for network management and monitoring.

Note No specific command enables SNMPv3; the first **snmp-server** global configuration command (config), that you issue enables SNMPv3. Therefore, the sequence in which you issue the **snmp-server** commands for this task does not matter.

Step 1 **configure**

Example:

```
RP/0/RP0/CPU0:router# configure
```

Enters mode.

Step 2 (Optional) **snmp-server engineid local** *engine-id*

Example:

```
RP/0/RP0/CPU0:router# snmp-server engineID
local 00:00:00:09:00:00:00:a1:61:6c:20:61
```

Specifies the identification number of the local SNMP engine.

Step 3 **snmp-server view** *view-name oid-tree* {**included** | **excluded**}

Example:

```
RP/0/RP0/CPU0:router# snmp-server view
view_name 1.3.6.1.2.1.1.5 included
```

Creates or modifies a view record.

Step 4 **snmp-server group** *name* {**v1** | **v2c** | **v3** {**auth** | **noauth** | **priv**}} [**read** *view*] [**write** *view*] [**notify** *view*] [*access-list-name*]

Example:

```
RP/0/RP0/CPU0:router# snmp-server group
group_name v3 noauth read view_name1 write view_name2
```

Configures a new SNMP group or a table that maps SNMP users to SNMP views.

Step 5 **snmp-server user** *username groupname* {**v1** | **v2c** | **v3** [**auth** {**md5** | **sha**} {**clear** | **encrypted**} *auth-password* [**priv des56** {**clear** | **encrypted**} *priv-password*]]} [*access-list-name*]

Example:

```
RP/0/RP0/CPU0:router# snmp-server user
noauthuser group_name v3
```

Configures a new user to an SNMP group.

Step 6 Use the **commit** or **end** command.

commit —Saves the configuration changes and remains within the configuration session.

end —Prompts user to take one of these actions:

- **Yes** — Saves configuration changes and exits the configuration session.
- **No** —Exits the configuration session without committing the configuration changes.
- **Cancel** —Remains in the configuration session, without committing the configuration changes.

Step 7 (Optional) **show snmp**

Example:

```
RP/0/RP0/CPU0:router# show snmp
```

Displays information about the status of SNMP.

Step 8 (Optional) **show snmp engineid**

Example:

```
RP/0/RP0/CPU0:router# show snmp engineid
```

Displays information about the local SNMP engine.

Step 9 (Optional) **show snmp group**

Example:

```
RP/0/RP0/CPU0:router# show snmp group
```

Displays information about each SNMP group on the network.

Step 10 (Optional) **show snmp users**

Example:

```
RP/0/RP0/CPU0:router# show snmp users
```

Displays information about each SNMP username in the SNMP users table.

Step 11 (Optional) **show snmp view**

Example:

```
RP/0/RP0/CPU0:router# show snmp view
```

Displays information about the configured views, including the associated MIB view family name, storage type, and status.

Configure to Drop Error PDUs

Perform this configuration to avoid error PDUs being sent out of router when polled with incorrect SNMPv3 user name. If the configuration is not set, it will respond with error PDUs by default. After applying this configuration, when router is polled with unknown SNMPv3 user name, the NMS will get time out instead of getting unknown user name error code.

Step 1 **configure**

Example:

```
RP/0/RP0/CPU0:router# configure
```

Enters mode.

Step 2 **snmp-server drop unknown-user**

Example:

```
RP/0/RP0/CPU0:router(config)# snmp-server drop unknown-user
```

Drop the error PDUs when the router is polled with incorrect SNMPv3 user name.

Step 3 Use the **commit** or **end** command.

commit —Saves the configuration changes and remains within the configuration session.

end —Prompts user to take one of these actions:

- **Yes** — Saves configuration changes and exits the configuration session.
- **No** —Exits the configuration session without committing the configuration changes.
- **Cancel** —Remains in the configuration session, without committing the configuration changes.

Configuring SNMPv3: Examples

Setting an Engine ID

This example shows how to set the identification of the local SNMP engine:

```
snmp-server engineID local 00:00:00:09:00:00:00:a1:61:6c:20:61
```

Note After the engine ID has been configured, the SNMP agent restarts.

Verifying the Identification of the Local SNMP Engines

This example shows how to verify the identification of the local SNMP engine:

```
config
  show snmp engineid

  SNMP engineID 00000009000000a1ffffffff
```

Creating a View

There are two ways to create a view:

- You can include the object identifier (OID) of an ASN.1 subtree of a MIB family from a view by using the **included** keyword of the **snmp-server view** command.
- You can exclude the OID subtree of the ASN.1 subtree of a MIB family from a view by using the **excluded** keyword of the **snmp-server view** command.

This example shows how to create a view that includes the sysName (1.3.6.1.2.1.1.5) object:

```
config
  snmp-server view SNMP_VIEW1 1.3.6.1.2.1.1.5 included
```

This example shows how to create a view that includes all the OIDs of a system group:

```
config
  snmp-server view SNMP_VIEW1 1.3.6.1.2.1.1 included
```

This example shows how to create a view that includes all the OIDs under the system group except the sysName object (1.3.6.1.2.1.1.5), which has been excluded:

```
config
  snmp-server view SNMP_VIEW1 1.3.6.1.2.1.1 included
  snmp-server view SNMP_VIEW1 1.3.6.1.2.1.1.5 excluded
```

Verifying Configured Views

This example shows how to display information about the configured views:

```
RP/0/RP0/CPU0:router# show snmp view

  v1default 1.3.6.1 - included nonVolatile active
  SNMP_VIEW1 1.3.6.1.2.1.1 - included nonVolatile active
```

```
  SNMP_VIEW1 1.3.6.1.2.1.1.5 - excluded nonVolatile active
```

Creating Groups

If you do not explicitly specify a notify, read, or write view, the Cisco IOS XR software uses the v1 default (1.3.6.1). This example shows how to create a group that utilizes the default view:

```
RP/0/RP0/CPU0:router# snmp-server group group-name v3 auth
```

The following configuration example shows how to create a group that has read access to all the OIDs in the system except the sysUpTime object (1.3.6.1.2.1.1.3), which has been excluded from the view applied to the group, but write access only to the sysName object (1.3.6.1.2.1.1.5):

```
!
  snmp-server view view_name1 1.3.6.1.2.1.1 included
  snmp-server view view_name1 1.3.6.1.2.1.1.3 excluded
  snmp-server view view_name2 1.3.6.1.2.1.1.5 included
  snmp-server group group_name1 v3 auth read view_name1 write view_name2
  !
```

Verifying Groups

This example shows how to verify the attributes of configured groups:

```
RP/0/RP0/CPU0:router# show snmp group

  groupname: group_name1                  security model:usm
  readview : view_name1                   writeview: view_name2
  notifyview: v1default
  row status: nonVolatile
```

Creating and Verifying Users

Given the following SNMPv3 view and SNMPv3 group configuration:

```
!
  snmp-server view view_name 1.3.6.1.2.1.1 included
  snmp-server group group_name v3 noauth read view_name write view-name
  !
```

This example shows how to create a noAuthNoPriv user with read and write view access to a system group:

```
config
  snmp-server user noauthuser group_name v3
```

Note The user must belong to a noauth group before a noAuthNoPriv user can be created.

This example shows how to verify the attributes that apply to the SNMP user:

```
RP/0/RP0/CPU0:router# show snmp user

  User name: noauthuser
  Engine ID: localSnmpID
  storage-type: nonvolatile active
```

Given the following SNMPv3 view and SNMPv3 group configuration:

```
!
  snmp-server view SNMP_VIEW1 1.3.6.1.2.1.1 included
  snmp-server group SNMP_GROUP1 v3 auth notify SNMP_VIEW1 read SNMP_VIEW1 write SNMP_VIEW1
 !
```

This example shows how to create a user with authentication (including encryption), read, and write view access to a system group:

```
config
  snmp-server user userv3authpriv SNMP_GROUP1 v3 auth md5 password123 priv aes 128 password123
```

Given the following SNMPv3 view and SNMPv3 group configuration:

```
!
  snmp-server view view_name 1.3.6.1.2.1.1 included
  snmp group group_name v3 priv read view_name write view_name
  !
```

This example shows how to create authNoPriv user with read and write view access to a system group:

```
RP/0/RP0/CPU0:router# snmp-server user authuser group_name v3 auth md5 clear auth_passwd
```

Note As the group is configured at a security level of Auth, the user must be configured as “auth” at a minimum to access this group (“priv” users could also access this group). The authNoPriv user configured in this group, authuser, must supply an authentication password to access the view. In the example, auth_passwd is set as the authentication password string. Note that **clear** keyword is specified before the auth_passwd password string. The **clear** keyword indicates that the password string being supplied is unencrypted.

This example shows how to verify the attributes that apply to SNMP user:

```
RP/0/RP0/CPU0:router# show snmp user

  User name: authuser
```

```
  Engine ID: localSnmpID
  storage-type: nonvolatile active
```

Given the following SNMPv3 view and SNMPv3 group configuration:

```
!
  snmp view view_name 1.3.6.1.2.1.1 included
  snmp group group_name v3 priv read view_name write view_name
  !
```

This example shows how to create an authPriv user with read and write view access to a system group:

```
config
  snmp-server user privuser group_name v3 auth md5 clear auth_passwd priv des56 clear
priv_passwd
```

Note As the group has a security level of Priv, the user must be configured as a "priv" user to access this group. In this example, the user, privuser, must supply both an authentication password and privacy password to access the OIDs in the view.

This example shows how to verify the attributes that apply to the SNMP user:

```
RP/0/RP0/CPU0:router# show snmp user

  User name: privuser
  Engine ID: localSnmpID
  storage-type: nonvolatile active
```

Configuring SNMP Trap Notifications

The following example shows how to configure the router to send SNMP trap notifications.

Step 1 **configure**

Example:

```
RP/0/RP0/CPU0:router# configure
```

Enters mode.

Step 2 **snmp-servergroup***name*{**v1v2v3**{**auth** | **noauth** | **priv**}}[**read***view*]**write***view*] [**notify***view*] [*access-list-name*]

Example:

```
RP/0/RP0/CPU0:router# snmp-server group group_name v3 noauth read view_name1 writer view_name2
```

Configures a new SNMP group or a table that maps SNMP users to SNMP views.

Step 3 **snmp-serveruser***groupname*{**v1v2cv3**{**auth** | **md5** | **sha**}{**clear** | **encrypted**}*auth-password*] [**priv des56** {**clear** | *access-list-name*]

Example:

```
RP/0/RP0/CPU0:router# snmp-server group group_name v3 noauth read view_name1 writer view_name2
```

Configures a new SNMP group or a table that maps SNMP users to SNMP views.

Step 4 **snmp-serveruser***usernamegroupname*{**v1v2cv3**{**auth** | **md5** | **sha**}{**clear** | **encrypted**}*auth-password*] [**priv des56** {**clear** | *access-list-name*]

Example:

```
RP/0/RP0/CPU0:routerconfig# snmp-server user noauthuser group_name v3
```

Configures a new SNMP group or a table that maps SNMP users to SNMP views.

Step 5 [**snmp-server host** *address* [**traps**] [**version** {**1** | **2c** | **3** [**auth** | **noauth** | **priv**]}] *community-string* [**udp-port** *port*] [*notification-type*]

Example:

```
RP/0/RP0/CPU0:router(config)# snmp-server host 12.26.25.61 traps version 3
noauth userV3noauth
```

Specifies SNMP trap notifications, the version of SNMP to use, the security level of the notifications, and the recipient (host) of the notifications.

Step 6 **snmp-server traps** [*notification-type*]

Example:

```
RP/0/RP0/CPU0:router(config)# snmp-server traps bgp
```

Enables the sending of trap notifications and specifies the type of trap notifications to be sent.

- If a trap is not specified with the *notification-type* argument, all supported trap notifications are enabled on the router. To display which trap notifications are available on your router, enter the **snmp-server traps ?** command.

Step 7 Use the **commit** or **end** command.

commit —Saves the configuration changes and remains within the configuration session.

end —Prompts user to take one of these actions:

- **Yes** — Saves configuration changes and exits the configuration session.
- **No** —Exits the configuration session without committing the configuration changes.
- **Cancel** —Remains in the configuration session, without committing the configuration changes.

Step 8 (Optional) **show snmp host**

Example:

```
RP/0/RP0/CPU0:router# show snmp host
```

Displays information about the configured SNMP notification recipient (host), port number, and security model.

Configure to Drop Error PDUs

Perform this configuration to avoid error PDUs being sent out of router when polled with incorrect SNMPv3 user name. If the configuration is not set, it will respond with error PDUs by default. After applying this configuration, when router is polled with unknown SNMPv3 user name, the NMS will get time out instead of getting unknown user name error code.

Step 1 **configure**

Example:

```
RP/0/RP0/CPU0:router# configure
```

Enters mode.

Step 2 **snmp-server drop unknown-user**

Example:

```
RP/0/RP0/CPU0:router(config)# snmp-server drop unknown-user
```

Drop the error PDUs when the router is polled with incorrect SNMPv3 user name.

Step 3 Use the **commit** or **end** command.

commit —Saves the configuration changes and remains within the configuration session.

end —Prompts user to take one of these actions:

- **Yes** — Saves configuration changes and exits the configuration session.
- **No** —Exits the configuration session without committing the configuration changes.
- **Cancel** —Remains in the configuration session, without committing the configuration changes.

Configuring Trap Notifications: Example

The following example configures an SNMP agent to send out different types of traps. The configuration includes a v2c user, a noAuthNoPriv user, anauthNoPriv user, and an AuthPriv user.

Note The default User Datagram Protocol (UDP) port is 161. If you do not a specify a UDP port with the **udp-port** keyword and *port* argument, then the configured SNMP trap notifications are sent to port 161.

```
!
  snmp-server host 10.50.32.170 version 2c public udp-port 2345
  snmp-server host 10.50.32.170 version 3 auth userV3auth udp-port 2345
  snmp-server host 10.50.32.170 version 3 priv userV3priv udp-port 2345
  snmp-server host 10.50.32.170 version 3 noauth userV3noauth udp-port 2345
  snmp-server user userv2c groupv2c v2c
```

```
 snmp-server user userV3auth groupV3auth v3 auth md5 encrypted 140F0A13
 snmp-server user userV3priv groupV3priv v3 auth md5 encrypted 021E1C43 priv des56 encrypted
1110001C
 snmp-server user userV3noauth groupV3noauth v3 LROwner
 snmp-server view view_name 1.3 included
 snmp-server community public RW
 snmp-server group groupv2c v2c read view_name
 snmp-server group groupV3auth v3 auth read view_name
 snmp-server group groupV3priv v3 priv read view_name
 snmp-server group groupV3noauth v3 noauth read view_name
 !
```

This example shows how to verify the configuration SNMP trap notification recipients host, the recipients of SNMP trap notifications. The output displays the following information:

- IP address of the configured notification host
- UDP port where SNMP notification messages are sent
- Type of trap configured
- Security level of the configured user
- Security model configured

```
config
  show snmp host

  Notification host: 10.50.32.170 udp-port: 2345 type: trap
  user: userV3auth security model: v3 auth

  Notification host: 10.50.32.170 udp-port: 2345 type: trap
  user: userV3noauth security model: v3 noauth

  Notification host: 10.50.32.170 udp-port: 2345 type: trap
  user: userV3priv security model: v3 priv

  Notification host: 10.50.32.170 udp-port: 2345 type: trap
  user: userv2c security model: v2c
```

Setting the Contact, Location, and Serial Number of the SNMP Agent

This task explains how to set the system contact string, system location string, and system serial number of the SNMP agent.

Note The sequence in which you issue the **snmp-server** commands for this task does not matter.

Step 1 **configure**

Example:

```
RP/0/RP0/CPU0:router# configure
```

Enters mode.

Step 2 (Optional) **snmp-server contact** *system-contact-string*

Example:

```
RP/0/RP0/CPU0:router(config)# snmp-server contact
Dial System Operator at beeper # 27345
```

Sets the system contact string.

Step 3 (Optional) **snmp-server location** *system-location*

Example:

```
RP/0/RP0/CPU0:router(config)# snmp-server location
Building 3/Room 214
```

Sets the system location string.

Step 4 (Optional) **snmp-server chassis-id** *serial-number*

Example:

```
RP/0/RP0/CPU0:router(config)# snmp-server chassis-id 1234456
```

Sets the system serial number.

Step 5 Use the **commit** or **end** command.

commit —Saves the configuration changes and remains within the configuration session.

end —Prompts user to take one of these actions:

- **Yes** — Saves configuration changes and exits the configuration session.
- **No** —Exits the configuration session without committing the configuration changes.
- **Cancel** —Remains in the configuration session, without committing the configuration changes.

Defining the Maximum SNMP Agent Packet Size

This task shows how to configure the largest SNMP packet size permitted when the SNMP server is receiving a request or generating a reply.

Note The sequence in which you issue the **snmp-server** commands for this task does not matter.

Step 1 **configure**

Example:

```
RP/0/RP0/CPU0:router# configure
```

Enters mode.

Step 2 (Optional) **snmp-server packetsize** *byte-count*

Example:

```
RP/0/RP0/CPU0:router(config)# snmp-server packetsize 1024
```

Sets the maximum packet size.

Step 3 Use the **commit** or **end** command.

commit —Saves the configuration changes and remains within the configuration session.

end —Prompts user to take one of these actions:

- **Yes** — Saves configuration changes and exits the configuration session.
- **No** —Exits the configuration session without committing the configuration changes.
- **Cancel** —Remains in the configuration session, without committing the configuration changes.

Changing Notification Operation Values

After SNMP notifications have been enabled, you can specify a value other than the default for the source interface, message queue length, or retransmission interval.

This task explains how to specify a source interface for trap notifications, the message queue length for each host, and the retransmission interval.

Note The sequence in which you issue the **snmp-server** commands for this task does not matter.

Step 1 **configure**

Example:

```
RP/0/RP0/CPU0:router# configure
```

Enters mode.

Step 2 (Optional) **snmp-server trap-source** *type interface-path-id*

Example:

```
RP/0/RP0/CPU0:router(config)# snmp-server trap-source POS 0/0/1/0
```

Specifies a source interface for trap notifications.

Step 3 (Optional) **snmp-server queue-length** *length*

Example:

```
RP/0/RP0/CPU0:router(config)# snmp-server queue-length 20
```

Establishes the message queue length for each notification.

Step 4 (Optional) **snmp-server trap-timeout** *seconds*

Example:

```
RP/0/RP0/CPU0:router(config)# snmp-server trap-timeout 20
```

Defines how often to resend notifications on the retransmission queue.

Step 5 Use the **commit** or **end** command.

commit —Saves the configuration changes and remains within the configuration session.

end —Prompts user to take one of these actions:

- **Yes** — Saves configuration changes and exits the configuration session.
- **No** —Exits the configuration session without committing the configuration changes.
- **Cancel** —Remains in the configuration session, without committing the configuration changes.

Setting IP Precedence and DSCP Values

This task describes how to configure IPv4 Precedence or IPv4 DSCP for SNMP traffic.

Before you begin

SNMP must be configured.

Step 1 **configure**

Example:

```
RP/0/RP0/CPU0:router# configure
```

Enters mode.

Step 2 Use one of the following commands:

- **snmp-server ipv4 precedence** *value*
- **snmp-server ipv4 dscp** *value*

Example:

```
RP/0/RP0/CPU0:router(config)# snmp-server dscp 24
```

Configures an IPv4 precedence or IPv4 DSCP value for SNMP traffic.

Step 3 Use the **commit** or **end** command.

commit —Saves the configuration changes and remains within the configuration session.

end —Prompts user to take one of these actions:

- **Yes** — Saves configuration changes and exits the configuration session.
- **No** —Exits the configuration session without committing the configuration changes.
- **Cancel** —Remains in the configuration session, without committing the configuration changes.

Setting IPv6 Precedence and DSCP Values

This task describes how to configure IPv6 Precedence or IPv6 DSCP for SNMP traffic.

Before you begin

SNMP must be configured.

Step 1 **configure**

Example:

```
RP/0/RP0/CPU0:router# configure
```

Enters mode.

Step 2 Use one of the following commands:

- **snmp-server ipv6 precedence** *value*
- **snmp-server ipv6 dscp** *value*

Example:

```
RP/0/RP0/CPU0:router(config)# snmp-server dscp 24
```

Configures an IPv6 precedence or IPv6 DSCP value for SNMP traffic.

Step 3 Use the **commit** or **end** command.

commit —Saves the configuration changes and remains within the configuration session.

end —Prompts user to take one of these actions:

- **Yes** — Saves configuration changes and exits the configuration session.
- **No** —Exits the configuration session without committing the configuration changes.
- **Cancel** —Remains in the configuration session, without committing the configuration changes.

Setting an IP Precedence Value for SNMP Traffic: Example

The following example shows how to set the SNMP IPv4 Precedence value to 7:

```
configure
  snmp-server ipv4 precedence 7
  exit

  Uncommitted changes found, commit them before exiting(yes/no/cancel)? [cancel]: y
```

The following example shows how to set the SNMP IPv6 Precedence value to 7:

```
configure
  snmp-server ipv6 precedence 7
  exit

  Uncommitted changes found, commit them before exiting(yes/no/cancel)? [cancel]: y
```

Setting an IP DSCP Value for SNMP Traffic: Example

The following example shows how to set the IPv4 DSCP value of SNMP traffic to 45:

```
configure
  snmp-server ipv4 dscp 45
  exit

  Uncommitted changes found, commit them before exiting(yes/no/cancel)? [cancel]: y
```

The following example shows how to set the IPv6 DSCP value of SNMP traffic to 45:

```
configure
  snmp-server ipv6 dscp 45
  exit

  Uncommitted changes found, commit them before exiting(yes/no/cancel)? [cancel]: y
```

Displaying SNMP Context Mapping

The SNMP agent serves queries based on SNMP contexts created by the client features. There is a context mapping table. Each entry in the context mapping table includes a context name, the name of the feature that created the context, and the name of the specific instance of the feature.

show snmp context-mapping

Example:

```
RP/0/RP0/CPU0:router# show snmp context-mapping
```

Displays the SNMP context mapping table.

Monitoring Packet Loss

It is possible to monitor packet loss by configuring the generation of SNMP traps when packet loss exceeds a specified threshold. The configuration described in this task enables the creation of entries in the MIB tables of the EVENT-MIB. This can then be monitored for packet loss using SNMP GET operations.

Before you begin

Note Entries created in the EVENT-MIB MIB tables using the configuration described in this task cannot be altered using an SNMP SET.

Entries to the EVENT-MIB MIB tables created using an SNMP SET cannot be altered using the configuration described in this task.

snmp-server mibs eventmib packet-loss *type interface-path-id* **falling** *lower-threshold* **interval** *sampling-interval* **rising** *upper-threshold*

Example:

```
RP/0/RP0/CPU0:router(config)# snmp-server mibs eventmib packet-loss falling 1 interval 5 rising 2
```

Generates SNMP EVENT-MIB traps for the interface when the packet loss exceeds the specified thresholds. Up to 100 interfaces can be monitored.

falling *lower-threshold* —Specifies the lower threshold. When packet loss between two intervals falls below this threshold and an mteTriggerRising trap was generated previously, a SNMP mteTriggerFalling trap is generated. This trap is not generated until the packet loss exceeds the upper threshold and then falls back below the lower threshold.

interval *sampling-interval* —Specifies how often packet loss statistics are polled. This is a value between 5 and 1440 minutes, in multiples of 5.

rising *upper-threshold* —Specifies the upper threshold. When packet loss between two intervals increases above this threshold, an SNMP mteTriggreRising trap is generated. This trap is not generated until the packet loss drops below the lower threshold and then rises above the upper threshold.

Configuring MIB Data to be Persistent

Many SNMP MIB definitions define arbitrary 32-bit indices for their object tables. MIB implementations often do a mapping from the MIB indices to some internal data structure that is keyed by some other set of data. In these MIB tables the data contained in the table are often other identifiers of the element being modelled. For example, in the ENTITY-MIB, entries in the entPhysicalTable are indexed by the 31-bit value, entPhysicalIndex, but the entities could also be identified by the entPhysicalName or a combination of the other objects in the table.

Because of the size of some MIB tables, significant processing is required to discover all the mappings from the 32-bit MIB indices to the other data which the network management station identifies the entry. For this reason, it may be necessary for some MIB indices to be persistent across process restarts, switchovers, or device reloads. The ENTITY-MIB entPhysicalTable and CISCO-CLASS-BASED-QOS-MIB are two such MIBs that often require index values to be persistent.

Also, because of query response times and CPU utilization during CISCO-CLASS-BASED-QOS-MIB statistics queries, it is desirable to cache service policy statistics.

Step 1 (Optional) **snmp-server mibs cbqosmib persist**

Example:

```
RP/0/RP0/CPU0:router(config)# snmp-server mibs cbqosmib persist
```

Enables persistent storage of the CISCO-CLASS-BASED-QOS-MIB data.

Step 2 (Optional) **snmp-server cbqosmib cache refresh time** *time*

Example:

```
RP/0/RP0/CPU0:router(config)# snmp-server mibs cbqosmib cache
refresh time 45
```

Enables QoS MIB caching with a specified cache refresh time.

Step 3 (Optional) **snmp-server cbqosmib cache service-policy count** *count*

Example:

```
RP/0/RP0/CPU0:router(config)# snmp-server mibs cbqosmib cache
service-policy count 50
```

Enables QoS MIB caching with a limited number of service policies to cache.

Step 4 **snmp-server ifindex persist**

Example:

```
RP/0/RP0/CPU0:router(config)# snmp-server ifindex persist
```

Enables if Index persistence globally on all Simple Network Management Protocol (SNMP) interfaces.

Configuring LinkUp and LinkDown Traps for a Subset of Interfaces

By specifying a regular expression to represent the interfaces for which you are interested in setting traps, you can enable or disable linkUp and linkDown traps for a large number of interfaces simultaneously.

Before you begin

SNMP must be configured.

Step 1 **configure**

Example:

```
RP/0/RP0/CPU0:router# configure
```

Enters mode.

Step 2 **snmp-server interface subset** *subset-number* **regular-expression** *expression*

Example:

```
RP/0/RP0/CPU0:router(config)# snmp-server interface subset 10
    regular-expression "^Gig[a-zA-Z]+[0-9/]+\."
RP/0/RP0/CPU0:router(config-snmp-if-subset)#
```

Enters snmp-server interface mode for the interfaces identified by the regular expression.

The subset-number argument identifies the set of interfaces, and also assigns a priority to the subset in the event that an interface is included in more than one subset. Lower numbers have higher priority and their configuration takes precedent over interface subsets with higher numbers.

The *expression* argument must be entered surrounded by double quotes.

Step 3 **notification linkupdown disable**

Example:

```
RP/0/RP0/CPU0:router(config-snmp-if-subset)# notification linkupdown disable
```

Disables linkUp and linkDown traps for all interfaces being configured. To enable previously disabled interfaces, use the **no** form of this command.

Step 4 Use the **commit** or **end** command.

commit —Saves the configuration changes, and remains within the configuration session.

end —Prompts user to take one of these actions:

- **Yes** — Saves configuration changes and exits the configuration session.
- **No** —Exits the configuration session without committing the configuration changes.
- **Cancel** —Remains in the configuration mode, without committing the configuration changes.

Step 5 (Optional) **show snmp interface notification subset** *subset-number*

Example:

```
RP/0/RP0/CPU0:router# show snmp interface notification subset 10
```

Displays the linkUp and linkDown notification status for all interfaces identified by the subset priority.

Step 6 (Optional) **show snmp interface notification regular-expression** *expression*

Example:

```
RP/0/RP0/CPU0:router# show snmp interface notification
    regular-expression "^Gig[a-zA-Z]+[0-9/]+\."
```

Displays the linkUp and linkDown notification status for all interfaces identified by the regular expression.

Step 7 (Optional) **show snmp interface notification** *type interface-path-id*

Example:

```
RP/0/RP0/CPU0:router# show snmp interface notification
    tengige 0/4/0/3.10
```

Displays the linkUp and linkDown notification status for the specified interface.

Polling BRIDGE-MIB

BRIDGE-MIB defines the managed objects for MAC-bridges between LAN segments, based on the IEEE802.1d standard. This MIB also supports managing Transparent Bridges, which includes Control-Ethernet and VPLS bridges.

To poll this MIB, do one of the following:

- For SNMPv2: Use a community and map to the context with proper name
- For SNMPv3: Use a group attached to the context

To display the SNMP context mapping table, use the **show snmp context-mapping** command:

```
RP/0/RP0/CPU0:router# show snmp context-mapping
Context-name                    Feature-name                    Feature
ControlEthernet0_RP0_CPU0_S0    ControlEthernet0_RP0_CPU0_S0    BRIDGEINST
ControlEthernet0_RP1_CPU0_S0    ControlEthernet0_RP1_CPU0_S0    BRIDGEINST

RP/0/RP0/CPU0:router# show running-config snmp-server
snmp-server community cebridge1 RW SystemOwner
snmp-server context    ControlEthernet0_RP0_CPU0_S0
snmp-server community-map cebridge1 context     ControlEthernet0_RP0_CPU0_S0
```

In the above example, the community name is **cebridge1**, and the context name is **ControlEthernet0_RP0_CPU0_S0**.

The format of the context name is as follows:

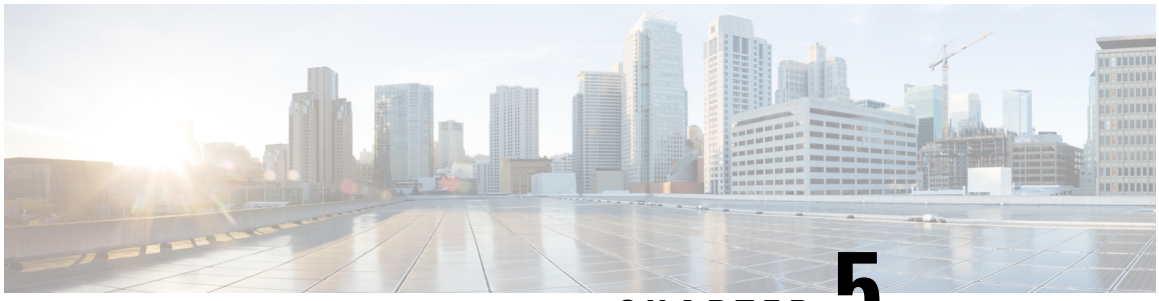
- Control-Ethernet bridges – **ControlEthernet***rack_slot_module_*[**S0**|**S1**]
- VPLS bridges – **vpls_***bridge_domain_name*

To configure the recipient of an SNMP notification operation, use the **snmp-server host** command:

```
RP/0/RSP0/CPU0:router(config)# snmp-server host 223.255.254.249 traps version 2c cebridge1
 udp-port 1567
```

To enable BRIDGE-MIB trap notifications, use the **snmp-server traps bridgemib** command:

```
RP/0/RSP0/CPU0:router(config)# snmp-server traps bridgemib
```



CHAPTER 5

Configuring Periodic MIB Data Collection and Transfer

This document describes how to periodically transfer selected MIB data from your router to a specified Network Management System (NMS). The periodic MIB data collection and transfer feature is also known as bulk statistics.

Prerequisites for Periodic MIB Data Collection and Transfer

To use periodic MIB data collection and transfer, you should be familiar with the Simple Network Management Protocol (SNMP) model of management information. You should also know what MIB information you want to monitor on your network devices, and the OIDs or object names for the MIB objects to be monitored.

Information About Periodic MIB Data Collection and Transfer

SNMP Objects and Instances

A type (or class) of SNMP management information is called an object. A specific instance from a type of management information is called an object instance (or SNMP variable). To configure a bulk statistics collection, you must specify the object types to be monitored using a bulk statistics object list and the specific instances of those objects to be collected using a bulk statistics schema.

MIBs, MIB tables, MIB objects, and object indices can all be specified using a series of numbers called an object identifier (OID). OIDs are used in configuring a bulk statistics collection in both the bulk statistics object lists (for general objects) and in the bulk statistics schemas (for specific object instances).

Bulk Statistics Object Lists

To group the MIB objects to be polled, you need to create one or more object lists. A bulk statistics object list is a user-specified set of MIB objects that share the same MIB index. Object lists are identified using a name that you specify. Named bulk statistics object lists allow the same configuration to be reused in different bulk statistics schemas.

All the objects in an object list must share the same MIB index. However, the objects do not need to be in the same MIB and do not need to belong to the same MIB table. For example, it is possible to group ifInOctets and a CISCO-IF-EXTENSION-MIB object in the same schema, because the containing tables for both objects are indexed by the ifIndex.

Bulk Statistics Schemas

Data selection for the Periodic MIB Data Collection and Transfer Mechanism requires the definition of a schema with the following information:

- Name of an object list.
- Instance (specific instance or series of instances defined using a wild card) that needs to be retrieved for objects in the specified object list.
- How often the specified instances need to be sampled (polling interval). The default polling interval is 5 minutes.

A bulk statistics schema is also identified using a name that you specify. This name is used when configuring the transfer options.

Bulk Statistics Transfer Options

After configuring the data to be collected, a single virtual file (VFile or *bulk statistics file*) with all collected data is created. This file can be transferred to a network management station using FTP or TFTP. You can specify how often this file should be transferred. The default transfer interval is once every 30 minutes. You can also configure a secondary destination for the file to be used if, for whatever reason, the file cannot be transferred to the primary network management station.

The value of the transfer interval is also the collection period (collection interval) for the local bulk statistics file. After the collection period ends, the bulk statistics file is frozen, and a new local bulk statistics file is created for storing data. The frozen bulk statistics file is then transferred to the specified destination.

By default, the local bulk statistics file is deleted after successful transfer to an network management station.

Benefits of Periodic MIB Data Collection and Transfer

Periodic MIB data collection and transfer (bulk statistics feature) allows many of the same functions as the bulk file MIB (CISCO-BULK-FILE-MIB.my), but offers some key advantages. The main advantage is that this feature can be configured through the CLI and does not require an external monitoring application.

Periodic MIB data collection and transfer is mainly targeted for medium to high-end platforms that have sufficient local storage (volatile or permanent) to store bulk statistics files. Locally storing bulk statistics files helps minimize loss of data during temporary network outages.

This feature also has more powerful data selection features than the bulk file MIB; it allows grouping of MIB objects from different tables into data groups (object lists). It also incorporates a more flexible instance selection mechanism, where the application is not restricted to fetching an entire MIB table.

How to Configure Periodic MIB Data Collection and Transfer

Configuring a Bulk Statistics Object List

The first step in configuring the Periodic MIB Data Collection and Transfer Mechanism is to configure one or more object lists.

Step 1 **configure**

Example:

```
RP/0/RP0/CPU0:router# configure
```

Enters mode.

Step 2 **snmp-server mib bulkstat object-list** *list-name*

Example:

```
snmp-server mib bulkstat object-list ifMib
```

Defines an SNMP bulk statistics object list and enters bulk statistics object list configuration mode.

Step 3 **add** {**oid** | *object-name*}

Example:

```
RP/0/RP0/CPU0:router(config-bulk-objects)# add 1.3.6.1.2.1.2.2.1.11
RP/0/RP0/CPU0:router(config-bulk-objects)# add ifAdminStatus
RP/0/RP0/CPU0:router(config-bulk-objects)# add ifDescr
```

Adds a MIB object to the bulk statistics object list. Repeat as desired until all objects to be monitored in this list are added.

Note All the objects in a bulk statistics object list have to be indexed by the same MIB index. However, the objects in the object list do not need to belong to the same MIB or MIB table.

When specifying an object name instead of an OID (using the add command), only object names with mappings shown in the **show snmp mib object** command output can be used.

Step 4 Use the **commit** or **end** command.

commit —Saves the configuration changes and remains within the configuration session.

end —Prompts user to take one of these actions:

- **Yes** — Saves configuration changes and exits the configuration session.
- **No** —Exits the configuration session without committing the configuration changes.

- **Cancel** —Remains in the configuration session, without committing the configuration changes.

Configuring a Bulk Statistics Schema

The second step in configuring periodic MIB data collection and transfer is to configure one or more schemas.

Before you begin

The bulk statistics object list to be used in the schema must be defined.

Step 1 **configure**

Example:

```
RP/0/RP0/CPU0:router# configure
```

Enters mode.

Step 2 **snmp-server mib bulkstat schema** *schema-name*

Example:

```
RP/0/RP0/CPU0:router(config)# snmp-server mib
bulkstat schema intE0
RP/0/RP0/CPU0:router(config-bulk-sc)#
```

Names the bulk statistics schema and enters bulk statistics schema mode.

Step 3 **object-list** *list-name*

Example:

```
RP/0/RP0/CPU0:router(config-bulk-sc)# object-list
ifMib
```

Specifies the bulk statistics object list to be included in this schema. Specify only one object list per schema. If multiple object-list commands are executed, the earlier ones are overwritten by newer commands.

Step 4 Do one of the following:

- **instance exact** {**interface** *interface-id* [**sub-if**] | **oid** *oid*}
- **instance wild** {**interface** *interface-id* [**sub-if**] | **oid** *oid*}
- **instance range start** *oid* **end** *oid*
- **instance repetition** *oid* **max** *repeat-number*

Example:

```
RP/0/RP0/CPU0:router(config-bulk-sc)# instance
wild oid 1
```

or

```
RP/0/RP0/CPU0:router(config-bulk-sc)# instance
exact interface TenGigE 0/1.25
```

or

```
RP/0/RP0/CPU0:router(config-bulk-sc)# instance
range start 1 end 2
```

or

```
RP/0/RP0/CPU0:router(config-bulk-sc)# instance
repetition 1 max 4
```

Specifies the instance information for objects in this schema:

- The **instance exact** command indicates that the specified instance, when appended to the object list, represents the complete OID.
- The **instance wild** command indicates that all subindices of the specified OID belong to this schema. The wild keyword allows you to specify a partial, “wild carded” instance.
- The **instance range** command indicates a range of instances on which to collect data.
- The **instance repetition** command indicates data collection to repeat for a certain number of instances of a MIB object.

Note Only one **instance** command can be configured per schema. If multiple **instance** commands are executed, the earlier ones are overwritten by new commands.

Step 5 **poll-interval** *minutes*

Example:

```
RP/0/RP0/CPU0:router(config-bulk-sc)# poll-interval 10
```

Sets how often data should be collected from the object instances specified in this schema, in minutes. The default is once every 5 minutes. The valid range is from 1 to 20000.

Step 6 Use the **commit** or **end** command.

commit —Saves the configuration changes and remains within the configuration session.

end —Prompts user to take one of these actions:

- **Yes** — Saves configuration changes and exits the configuration session.
- **No** —Exits the configuration session without committing the configuration changes.
- **Cancel** —Remains in the configuration session, without committing the configuration changes.

Configuring Bulk Statistics Transfer Options

The final step in configuring periodic MIB data collection and transfer is to configure the transfer options. The collected MIB data are kept in a local file-like entity called a VFile (virtual file, referred to as a bulk statistics file in this document). This file can be transferred to a remote network management station at intervals you specify.

Before you begin

The bulk statistics object lists and bulk statistics schemas must be defined before configuring the bulk statistics transfer options.

Step 1 **configure**

Example:

```
RP/0/RP0/CPU0:router# configure
```

Enters mode.

Step 2 **snmp-server mib bulkstat transfer-id** *transfer-id*

Example:

```
RP/0/RP0/CPU0:router(config)# snmp-server mib
bulkstat transfer bulkstat1
```

Identifies the transfer configuration with a name (*transfer-id* argument) and enters bulk statistics transfer configuration mode.

Step 3 **buffer-size** *bytes*

Example:

```
RP/0/RP0/CPU0:router(config-bulk-tr)# buffersize 3072
```

(Optional) Specifies the maximum size for the bulk statistics data file, in bytes. The valid range is from 1024 to 2147483647 bytes. The default buffer size is 2048 bytes.

Note If the maximum buffer size for a bulk statistics file is reached before the transfer interval time expires, all additional data received is deleted. To correct this behavior, you can decrease the polling frequency, or increase the size of the bulk statistics buffer.

Step 4 **Example:**

(Optional) Specifies the format of the bulk statistics data file (VFile). The default is schemaASCII.

Note Transfers can only be performed using schemaASCII (cdcSchemaASCII) format. SchemaASCII is a human-readable format that contains parser-friendly hints for parsing data values.

Step 5 **schema** *schema-name*

Example:

```
RP/0/RP0/CPU0:router(config-bulk-tr)# schema TenGigE 0/5/0/11/1
RP/0/RP0/CPU0:router(config-bulk-tr)# schema TenGigE/0-CAR
RP/0/RP0/CPU0:router(config-bulk-tr)# schema TenGigE 0/5/0/11/1
```

Specifies the bulk statistics schema to be transferred. Repeat this command as desired. Multiple schemas can be associated with a single transfer configuration; all collected data are placed in a single bulk data file (VFile).

Step 6 **transfer-interval** *minutes*

Example:

```
RP/0/RP0/CPU0:router(config-bulk-tr)# transfer-interval 20
```

(Optional) Specifies how often the bulk statistics file are transferred, in minutes. The default value is once every 30 minutes. The transfer interval is the same as the collection interval.

Step 7 **url primary** *url*

Example:

```
RP/0/RP0/CPU0:router(config-bulk-tr)# url primary
ftp://user:password@host/folder/bulkstat1
```

Specifies the network management system (host) that the bulk statistics data file is transferred to, and the protocol to use for transfer. The destination is specified as a Uniform Resource Locator (URL). FTP or TFTP can be used for the bulk statistics file transfer.

Step 8 **url secondary** *url*

Example:

```
RP/0/RP0/CPU0:router(config-bulk-tr)# url secondary
tftp://10.1.0.1/tftpboot/user/bulkstat1
```

(Optional) Specifies a backup transfer destination and protocol for use in the event that transfer to the primary location fails. FTP or TFTP can be used for the bulk statistics file transfer.

Step 9 **retry** *number*

Example:

```
RP/0/RP0/CPU0:router(config-bulk-tr)# retry 1
```

(Optional) Specifies the number of transmission retries. The default value is 0 (in other words, no retries). If an attempt to send the bulk statistics file fails, the system can be configured to attempt to send the file again using this command.

One retry includes an attempt first to the primary destination then, if the transmission fails, to the secondary location. For example, if the retry value is 1, an attempt is made first to the primary URL, then to the secondary URL, then to the primary URL again, then to the secondary URL again. The valid range is from 0 to 100.

If all retries fail, the next normal transfer occurs after the configured transfer-interval time.

Step 10 **retain** *minutes*

Example:

```
RP/0/RP0/CPU0:router(config-bulk-tr)# retain 60
```

(Optional) Specifies how long the bulk statistics file should be kept in system memory, in minutes, after the completion of the collection interval and a transmission attempt is made. The default value is 0. Zero (0) indicates that the file is deleted immediately after the transfer is attempted. The valid range is from 0 to 20000.

Note If the retry command is used, you should configure a retain interval larger than 0. The interval between retries is the retain interval divided by the retry number. For example, if **retain 10** and **retry 2** are configured, two retries are attempted once every 5 minutes. Therefore, if retain 0 is configured, no retries are attempted.

Step 11 **enable**

Example:

```
RP/0/RP0/CPU0:router(config-bulk-tr)# enable
```

Begins the bulk statistics data collection and transfer process for this configuration.

- For successful execution of this action, at least one schema with non-zero number of objects must be configured.
- Periodic collection and file transfer begins only if this command is configured. Conversely, the **no enable** command stops the collection process. A subsequent **enable** starts the operations again.
- Each time the collection process is started using the **enable** command, data is collected into a new bulk statistics file. When the **no enable** command is used, the transfer process for any collected data immediately begins (in other words, the existing bulk statistics file is transferred to the specified management station).

Step 12 **commit** *minutes*

Example:

```
RP/0/RP0/CPU0:router(config-bulk-tr)# retain 60
```

If the maximum buffer size for a bulk statistics file is reached before the transfer interval time expires, the transfer operation is still initiated, but any bulk statistics data received after the file was full, and before it was transferred, are deleted. To correct this behavior, you can decrease the polling frequency, or increase the size of the bulk statistics buffer.

If **retain 0** is configured, no retries are attempted. This is because the interval between retries is the retain value divided by the retry value. For example, if **retain 10** and **retry 2** are configured, retries are attempted once every 5 minutes. Therefore, if you configure the retry command, you should also configure an appropriate value for the retain command.

Periodic MIB Data Collection and Transfer: Example

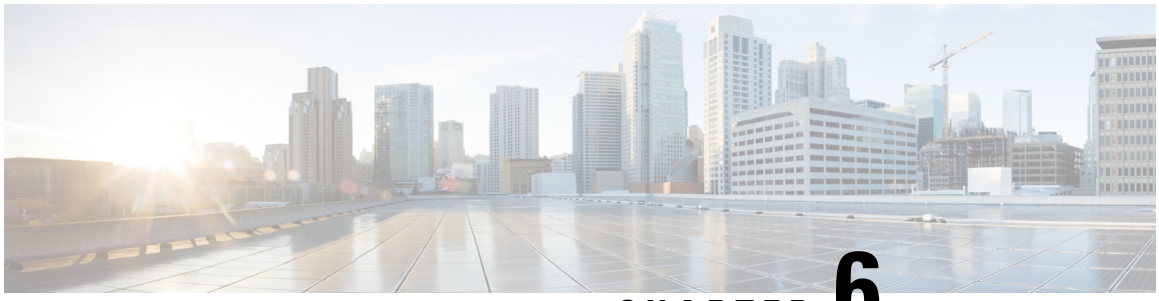
This example shows how to configure periodic MIB data collection and transfer:

```
snmp-server mib bulkstat object-list cempo
add cempMemPoolName
add cempMemPoolType
!
snmp-server mib bulkstat schema cempWild
object-list cempo
instance wild oid 8695772
poll-interval 1
!
snmp-server mib bulkstat schema cempRepeat
object-list cempo
instance repetition 8695772.1 max 4294967295
poll-interval 1
!
snmp-server mib bulkstat transfer-id cempt1
enable
url primary tftp://223.255.254.254/auto/tftp-sjc-users3/username/dumpdcm
schema cempWild
schema cempRepeat
transfer-interval 2
!
```

This example shows sample bulk statistics file content:

```
Schema-def cempt1.cempWild "%u, %s, %s, %d" Epochtime instanceoid
            1.3.6.1.4.1.9.9.221.1.1.1.1.3 1.3.6.1.4.1.9.9.221.1.1.1.1.2
cempt1.cempWild: 1339491515, 8695772.1, processor, 2
cempt1.cempWild: 1339491515, 8695772.2, reserved, 11
cempt1.cempWild: 1339491515, 8695772.3, image, 12
cempt1.cempWild: 1339491575, 8695772.1, processor, 2
cempt1.cempWild: 1339491575, 8695772.2, reserved, 11
cempt1.cempWild: 1339491575, 8695772.3, image, 12
Schema-def cempt1.cempRepeat "%u, %s, %s, %d" Epochtime instanceoid
            1.3.6.1.4.1.9.9.221.1.1.1.1.3 1.3.6.1.4.1.9.9.221.1.1.1.1.2
cempt1.cempRepeat: 1339491515, 8695772.1, processor, 2
cempt1.cempRepeat: 1339491515, 8695772.2, reserved, 11
cempt1.cempRepeat: 1339491515, 8695772.3, image, 12
```

```
cempt1.cempRepeat: 1339491515, 26932192.1, processor, 2
cempt1.cempRepeat: 1339491515, 26932192.2, reserved, 11
cempt1.cempRepeat: 1339491515, 26932192.3, image, 12
cempt1.cempRepeat: 1339491515, 35271015.1, processor, 2
cempt1.cempRepeat: 1339491515, 35271015.2, reserved, 11
cempt1.cempRepeat: 1339491515, 35271015.3, image, 12
cempt1.cempRepeat: 1339491515, 36631989.1, processor, 2
cempt1.cempRepeat: 1339491515, 36631989.2, reserved, 11
cempt1.cempRepeat: 1339491515, 36631989.3, image, 12
cempt1.cempRepeat: 1339491515, 52690955.1, processor, 2
cempt1.cempRepeat: 1339491515, 52690955.2, reserved, 11
cempt1.cempRepeat: 1339491515, 52690955.3, image, 12
```



CHAPTER 6

Configuring Cisco Discovery Protocol

Cisco Discovery Protocol (CDP) is a media- and protocol-independent protocol that runs on all Cisco-manufactured equipment including routers, bridges, access and communication servers, and switches. Using CDP, you can view information about all the Cisco devices that are directly attached to the device.

Prerequisites for Implementing CDP

To enable CDP, you must install the CDP package on your router.

You must be in a user group associated with a task group that includes the proper task IDs. The command reference guides include the task IDs required for each command. If you suspect user group assignment is preventing you from using a command, contact your AAA administrator for assistance.

Information About Implementing CDP

CDP is primarily used to obtain protocol addresses of neighboring devices and discover the platform of those devices. CDP can also be used to display information about the interfaces your router uses. CDP is media- and protocol-independent, and runs on all equipment manufactured by Cisco, including routers, bridges, access servers, and switches.

Use of SNMP with the CDP MIB allows network management applications to learn the device type and the SNMP agent address of neighboring devices and to send SNMP queries to those devices. CDP uses the CISCO-CDP-MIB.

CDP runs on all media that support Subnetwork Access Protocol (SNAP), including LAN, Frame Relay, and ATM physical media. CDP runs over the data link layer only. Therefore, two systems that support different network-layer protocols can learn about each other.

Each device configured for CDP sends periodic messages, known as *advertisements*, to a multicast address. Each device advertises at least one address at which it can receive SNMP messages. The advertisements also contain time-to-live, or hold-time, information, which indicates the length of time a receiving device holds

CDP information before discarding it. Each device also listens to the periodic CDP messages sent by others to learn about neighboring devices and determine when their interfaces to the media go up or down.

CDP Version-2 (CDPv2) is the most recent release of the protocol and provides more intelligent device tracking features. These features include a reporting mechanism that allows for more rapid error tracking, thereby reducing costly downtime. Reported error messages can be sent to the console or to a logging server, and can cover instances of unmatching native VLAN IDs (IEEE 802.1Q) on connecting ports, and unmatching port duplex states between connecting devices.

CDPv2 **show** commands can provide detailed output on VLAN Trunking Protocol (VTP) management domain and duplex modes of neighbor devices, CDP-related counters, and VLAN IDs of connecting ports.

Type-length-value fields (TLVs) are blocks of information embedded in CDP advertisements. This table summarizes the TLV definitions for CDP advertisements.

Table 6: Type-Length-Value Definitions for CDPv2

TLV	Definition
Device-ID TLV	Identifies the device name in the form of a character string.
Address TLV	Contains a list of network addresses of both receiving and sending devices.
Port-ID TLV	Identifies the port on which the CDP packet is sent.
Capabilities TLV	Describes the functional capability for the device in the form of a device type; for example, a switch.
Version TLV	Contains information about the software release version on which the device is running.
Platform TLV	Describes the hardware platform name of the device, for example, Cisco 4500.
VTP Management Domain TLV	Advertises the system's configured VTP management domain name-string. Used by network operators to verify VTP domain configuration in adjacent network nodes.
Native VLAN TLV	Indicates, per interface, the assumed VLAN for untagged packets on the interface. CDP learns the native VLAN for an interface. This feature is implemented only for interfaces that support the IEEE 802.1Q protocol.
Full/Half Duplex TLV	Indicates status (duplex configuration) of CDP broadcast interface. Used by network operators to diagnose connectivity problems between adjacent network elements.

How to Implement CDP on Cisco IOS XR Software

Enabling CDP

To enable CDP, you must first enable CDP globally on the router and then enable CDP on a per-interface basis. This example explains how to enable CDP globally on the router and then enable CDP on an interface.

```
Router:# configure
Router(config):# cdp
Router(config):# commit
```

```
Router:# configure
Router(config):# interface hundredGigE 0/0/0/4
Router(config-if):# cdp
Router(config-if):# commit
```

Modifying CDP Default Settings

This task explains how to modify the default version, hold-time setting, and timer settings.

Note The commands can be entered in any order.

Step 1 **configure**

Example:

```
RP/0/RP0/CPU0:router# configure
```

Enters mode.

Step 2 **cdp advertise v1**

Example:

```
RP/0/RP0/CPU0:router(config)# cdp advertise v1
```

Configures CDP to use only version 1 (CDPv1) in communicating with neighboring devices.

- By default, when CDP is enabled, the router sends CDPv2 packets. CDP also sends and receives CDPv1 packets if the device with which CDP is interacting does not process CDPv2 packets.
- In this example, the router is configured to send and receive only CDPv1 packets.

Step 3 **cdp holdtime** *seconds*

Example:

```
RP/0/RP0/CPU0:router(config)# cdp holdtime 30
```

Specifies the amount of time that the receiving networking device will hold a CDP packet sent from the router before discarding it.

- By default, when CDP is enabled, the receiving networking device holds a CDP packet for 180 seconds before discarding it.

  Note The CDP hold time must be set to a higher number of seconds than the time between CDP transmissions, which is set with the **cdp timer** command.

- In this example, the value of hold-time for the *seconds* argument is set to 30.

Step 4 **cdp timer** *seconds*

Example:

```
RP/0/RP0/CPU0:router(config)# cdp timer 20
```

Specifies the frequency at which CDP update packets are sent.

- By default, when CDP is enabled, CDP update packets are sent at a frequency of once every 60 seconds.

  Note A lower timer setting causes CDP updates to be sent more frequently.

- In this example, CDP update packets are configured to be sent at a frequency of once every 20 seconds.

Step 5 Use the **commit** or **end** command.

commit —Saves the configuration changes and remains within the configuration session.

end —Prompts user to take one of these actions:

- **Yes** — Saves configuration changes and exits the configuration session.
- **No** —Exits the configuration session without committing the configuration changes.
- **Cancel** —Remains in the configuration session, without committing the configuration changes.

Step 6 (Optional) **show cdp**

Example:

```
RP/0/RP0/CPU0:router# show cdp
```

Displays global CDP information.

The output displays the CDP version running on the router, the hold time setting, and the timer setting.

Monitoring CDP

This task shows how to monitor CDP.

Note The commands can be entered in any order.

Step 1 **show cdp entry** {***** | *entry-name*} [**protocol** | **version**]

Example:

```
RP/0/RP0/CPU0:router# show cdp entry *
```

Displays information about a specific neighboring device or all neighboring devices discovered using CDP.

Step 2 **show cdp interface** [*type interface-path-id* | **location** *node-id*]

Example:

```
RP/0/RP0/CPU0:router# show cdp interface pos 0/0/0/1
```

Displays information about the interfaces on which CDP is enabled.

Step 3 **show cdp neighbors** [*type interface-path-id* | **location** *node-id*] [**detail**]

Example:

```
RP/0/RP0/CPU0:router# show cdp neighbors
```

Displays detailed information about neighboring devices discovered using CDP.

Step 4 **show cdp traffic** [**location** *node-id*]

Example:

```
RP/0/RP0/CPU0:router# show cdp traffic
```

Displays information about the traffic gathered between devices using CDP.

Examples

The following is sample output for the **show cdp neighbors** command:

```
RP/0/RP0/CPU0:router# show cdp neighbors

  Capability Codes: R - Router, T - Trans Bridge, B - Source Route Bridge
                    S - Switch, H - Host, I - IGMP, r - Repeater

Device ID       Local Intrfce    Holdtme Capability Platform  Port ID
NCS5500         Hu0/0/0/4        15      R          NCS-5500  Hu0/0/0/4
```

The following is sample output for the **show cdp neighbors** command. In this example, the optional *type instance* arguments are used in conjunction with the **detail** optional keyword to display detailed information about a CDP neighbor. The output includes information on both IPv4 and IPv6 addresses.

```
RP/0/RP0/CPU0:router# show cdp neighbors hundredGigE 0/0/0/4 detail

  -------------------------
Device ID: NCS5500
SysName : NCS5500
Entry address(es):
```

```
  IPv4 address: 40.0.0.2
  IPv6 address: 10:10:10:10::1
Platform: cisco NCS-5500,  Capabilities: Router
Interface: HundredGigE0/0/0/4
Port ID (outgoing port): HundredGigE0/0/0/4
Holdtime : 13 sec

Version :
7.1.1.112I

advertisement version: 2
Duplex: full
```

The following is sample output for the **show cdp entry** command. In this example, the optional *entry* argument is used to display entry information related to a specific CDP neighbor.

```
RP/0/RP0/CPU0:router# show cdp entry NCS5500
 -------------------------
Device ID: NCS5500
SysName : NCS5500
Entry address(es):
  IPv4 address: 40.0.0.2
  IPv6 address: 10:10:10:10::1
Platform: cisco NCS-5500,  Capabilities: Router
Interface: HundredGigE0/0/0/4
Port ID (outgoing port): HundredGigE0/0/0/4
Holdtime : 11 sec

Version :
7.1.1.112I

advertisement version: 2
Duplex: full
```

The following is sample output for the **show cdp interface** command. In this example, CDP information related to interface 0/0/0/4 is displayed.

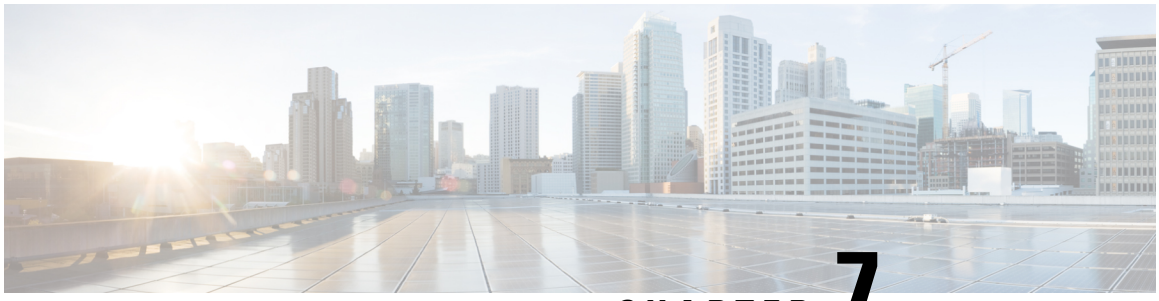
```
RP/0/RP0/CPU0:router# show cdp interface hundredGigE 0/0/0/4


  HundredGigE0/0/0/4 is Up
  Encapsulation ether
  Sending CDP packets every 60 seconds
  Holdtime is 180 seconds
```

The following is sample output for the **show cdp traffic** command:

```
RP/0/RP0/CPU0:router# show cdp traffic

 CDP counters :
        Packets output: 10, Input: 39
        Hdr syntax: 0, Chksum error: 0, Encaps failed: 0
        No memory: 0, Invalid packet: 0, Truncated: 0
        CDP version 1 advertisements output: 0, Input: 0
        CDP version 2 advertisements output: 10, Input: 39
        Unrecognize Hdr version: 0, File open failed: 0
```



CHAPTER 7

Configuring Call Home

This module describes the configuring of the Call Home feature.

Table 7: Feature History for Configuring Call Home

Release	Modification
Release 7.0.11	Call Home was introduced

This model contains the following topics:

About Call Home

Call Home provides an email and HTTPS based notification for critical system policies. A range of message formats are available for compatibility with pager services or XML-based automated parsing applications. You can use this feature to page a network support engineer, or email a Network Operations Center. You can also use Cisco Smart Call Home services to generate a case with the Technical Assistance Center. The Call Home feature can deliver alert messages containing information about diagnostics and environmental faults and events.

The Call Home feature can deliver alerts to multiple recipients, referred to as Call Home destination profiles. Each profile includes configurable message formats and content categories. A predefined destination is

provided for sending alerts to the Cisco TAC, however you also can define your own destination profiles. When you configure Call Home to send messages, the appropriate CLI show command is executed and the command output is attached to the message. Call Home messages are delivered in the following formats:

- Short text format which provides a one or two line description of the fault that is suitable for pagers or printed reports.
- Full text format which provides fully formatted message with detailed information that is suitable for human reading.
- XML machine-readable format that uses Extensible Markup Language (XML) and Adaptive Messaging Language (AML) XML schema definition (XSD). The AML XSD is published on the Cisco.com website at http://www.cisco.com. The XML format enables communication with the Cisco Systems Technical Assistance Center.

The Call Home feature is enabled by default. The Cisco TAC-1 profile is created after the device starts. The default Call Home settings that includes destination address, transport methods, alert-group subscriptions, and more are saved in the CiscoTAC-1 profile. To check the default settings, use the **show call-home profile CiscoTAC-1** command.

Benefits of Using Call Home

The Call Home feature offers the following benefits:

- Multiple message-format options:
  - Short Text—Suitable for pagers or printed reports.
  - Plain Text—Full formatted message information suitable for human reading.
  - XML—Matching readable format using Extensible Markup Language (XML) and Adaptive Markup Language (AML) document type definitions (DTDs). The XML format enables communication with the Cisco Smart Call Home server.
- Multiple concurrent message destinations.
- Multiple message categories, including configuration, environmental conditions, inventory, syslog, and crash events.
- Filtering of messages by severity and pattern matching.
- Scheduling of periodic message sending.

Prerequisites for Call Home

How you configure Call Home depends on how you intend to use the feature. Consider the following requirements before you configure Call Home:

- Obtain e-mail, phone, and street address information for the Call Home contact to be configured so that the receiver can determine the origin of messages received.
- Identify the name or IPv4 address of a primary Simple Mail Transfer Protocol (SMTP) server and any backup servers, if using e-mail message delivery.

- Verify IP connectivity from the router to the e-mail server(s) or the destination HTTP server.
- If Cisco Smart Call Home is used, an active service contract covering the device is required to provide full SCH service.

How to Configue Call Home

To configure the sending of Call Home messages, do the following:

1. Assign contact information.
2. Configure and enable one or more destination profiles.
3. Associate one or more alert groups to each profile.
4. Configure the email server options, if using e-mail message delivery.
5. Enable Call Home.

The above tasks are described in detail in the below procedures.

Note Before enabling Call-Home, you must configure the source interface for HTTPS over IPv6. However, for HTTPS over IPv4, Call-Home works without the source interface.

In case of a dual-stack call-home configuration on the device, the IPv4 address is preferred over the IPv6 address. This may result in IPv6 resolution failure. Due to this limitation, the IPv6 device registration with the licensing server may only be done with a single mode, that is, IPv6 only configuration.

Use the **http client source-interface ipv6** command to configure the source interface.

Configuring Contact Information

Each router must include a contact e-mail address. You can optionally include other identifying information for your system installation.

Step 1 **configure**

Example:

```
RP/0/RP0/CPU0:router# configure
```

Enters mode.

Step 2 **call-home**

Example:

```
RP/0/RP0/CPU0:router(config)# call-home
RP/0/RP0/CPU0:router(config-call-home)#
```

Enters call home configuration mode.

Step 3 **contact-email-addr** *email-address*

Example:

```
RP/0/RP0/CPU0:router(config-call-home)# contact-email-addr
user1@cisco.com
```

Configures the customer email address. Enter up to 200 characters in email address format with no spaces.

Step 4 (Optional) **contract-id** *contract-id-string*

Example:

```
RP/0/RP0/CPU0:router(config-call-home)# contract-id
Contract-identifier
```

Configures the contract ID. Enter up to 64 characters. If you include spaces, you must enclose the entry in quotes ("").

Step 5 (Optional) **customer-id** *customer-id-string*

Example:

```
RP/0/RP0/CPU0:router(config-call-home)# customer-id Customer1
```

Configures the customer ID. Enter up to 64 characters. If you include spaces, you must enclose the entry in quotes ("").

Step 6 (Optional) **phone-number** *phone-number-string*

Example:

```
RP/0/RP0/CPU0:router(config-call-home)# phone-number +405-123-4567
```

Configures the customer phone number. The number must begin with a plus (+) prefix, and may contain only dashes (-) and numbers. Enter up to 16 characters.

Step 7 (Optional) **street-address** *street-address*

Example:

```
RP/0/RP0/CPU0:router(config-call-home)# street-address "300 E. Tasman Dr.
San Jose, CA 95134"
```

Configures the customer street address where RMA equipment can be shipped. Enter up to 200 characters. If you include spaces, you must enclose the entry in quotes ("").

Step 8 (Optional) **site-id** *site-id-string*

Example:

```
RP/0/RP0/CPU0:router(config-call-home)# site-id SJ-RouterRoom1
```

Configures the site ID for the system. Enter up to 200 characters. If you include spaces, you must enclose the entry in quotes ("").

Step 9 Use the **commit** or **end** command.

commit —Saves the configuration changes and remains within the configuration session.

end —Prompts user to take one of these actions:

- **Yes** — Saves configuration changes and exits the configuration session.
- **No** —Exits the configuration session without committing the configuration changes.
- **Cancel** —Remains in the configuration session, without committing the configuration changes.

Step 10 **show call-home**

Example:

```
RP/0/RP0/CPU0:router# show call-home
```

Displays information about the system contacts.

Destination Profiles

A destination profile includes the following information:

- One or more alert groups—The group of alerts that trigger a specific Call Home message if the alert occurs.
- One or more e-mail or HTTPS destinations—The list of recipients for the Call Home messages generated by alert groups assigned to this destination profile.
- Message format—The format for the Call Home message (short text, full text, or XML).
- Message severity level—The Call Home severity level that the alert must meet before a Call Home message is sent to all e-mail and HTTPS URL addresses in the destination profile. An alert is not generated if the Call Home severity level of the alert is lower than the message severity level set for the destination profile. The inventory and configuration alert groups do not have concept of severity level. They are generated directly.

You can also configure a destination profile to allow periodic inventory update messages by using the inventory alert group that will send out periodic messages daily, weekly, or monthly.

The following predefined destination profiles are supported:

- CiscoTAC-1—Supports the Cisco-TAC alert group in XML message format.

Configuring and Activating Destination Profiles

You must have at least one activated destination profile for Call Home messages to be sent. The CiscoTAC-1 profile exists by default but is not active.

Step 1 **configure**

Example:

```
RP/0/RP0/CPU0:router# configure
```

Enters mode.

Step 2 **call-home**

Example:

```
RP/0/RP0/CPU0:router(config)# call-home
RP/0/RP0/CPU0:router(config-call-home)#
```

Enters call home configuration mode.

Step 3 **profile** *profile-name*

Example:

```
RP/0/RP0/CPU0:router(config-call-home)# profile my_profile
RP/0/RP0/CPU0:router(config-call-home-profile)#
```

Enters call home profile configuration mode to configure a new or existing profile.

Step 4 **destination address email** *email-address*

Example:

```
RP/0/RP0/CPU0:router(config-call-home-profile)# destination
address email support_me@cisco.com
```

Configures an email address to which Call Home messages are sent for this profile.

Step 5 **destination message-size-limit** *max-size*

Example:

```
RP/0/RP0/CPU0:router(config-call-home-profile)# destination
message-size-limit 1000
```

Configures the maximum size of Call Home messages for this profile. Values can be between 50 and 3145728 characters.

Step 6 **destination preferred-msg-format** {**short-text** | **long-text** | **xml**}

Example:

```
RP/0/RP0/CPU0:router(config-call-home-profile)# destination
preferred-msg-format xml
```

Configures the message format for this profile. The default is xml.

Step 7 **destination transport-method** [**email** | **hhtp**]

Example:

```
RP/0/RP0/CPU0:router(config-call-home-profile)# destination
transport-method email
```

Configures the transport method for this profile.

Step 8 **active**

Example:

```
RP/0/RP0/CPU0:router(config-call-home-profile)# active
```

Activates the destination profile.

Note At least one destination profile must be active for Call Home messages to be sent.

Step 9 Use the **commit** or **end** command.

commit —Saves the configuration changes and remains within the configuration session.

end —Prompts user to take one of these actions:

- **Yes** — Saves configuration changes and exits the configuration session.
- **No** —Exits the configuration session without committing the configuration changes.
- **Cancel** —Remains in the configuration session, without committing the configuration changes.

Step 10 **show call-home profile** {**all** | *profile-name*}

Example:

```
RP/0/RP0/CPU0:router# show call-home profile all
```

Displays information about the destination profile.

Call Home Alert Groups

An alert group is a predefined subset of alerts or events that Call Home detects and reports to one or more destinations. Alert groups allow you to select the set of alerts that you want to send to a predefined or custom destination profile. Alerts are sent to e-mail destinations in a destination profile only if that alert belongs to one of the alert groups associated with that destination profile and if the alert has a Call Home message severity at or above the message severity set in the destination profile.

The following table lists supported alert groups and the default CLI command output included in Call Home messages generated for the alert group.

Table 8: Alert Groups and Executed Commands

Alert Group	Description	Executed Commands
Environmental	Events related to power, fan, and environment-sensing elements such as temperature alarms.	• **show environment** • **show logging** • **show inventory** • **show environment trace** • **show diag**
Inventory	Inventory status that is provided whenever a unit is cold booted, or when FRUs are inserted or removed. This alert is considered a noncritical event, and the information is used for status and entitlement.	• **show platform** • **show version** • **show diag** • **show inventory oid**

Alert Group	Description	Executed Commands
Syslog	Events generated by specific interesting syslog messages	• **show version** • **show logging** • **show inventory**
Configuration	User-generated request for configuration or configuration change event.	• **show version** • **show running config all** • **show inventory** • **show configuration history last 30** • **show configuration commit changes last 1**
Snapshot	This alert group can be configured for periodic notifications	By default, this alert group has no commands to be run. You can add the required commands that need to be run.

Call Home maps the syslog severity level to the corresponding Call Home severity level for syslog port group messages.

Call Home Message Levels

Call Home allows you to filter messages based on their level of urgency. You can associate each destination profile (predefined and user-defined) with a Call Home message level threshold. The Call Home message level ranges from 0 (lowest level of urgency) to 9 (highest level of urgency). Call Home messages are generated if they have a severity level equal to or greater than the Call Home message level threshold for the destination profile.

Call Home messages that are sent for syslog alert groups have the syslog severity level mapped to the Call Home message level.

Note Call Home does not change the syslog message level in the message text.

The following table lists each Call Home message level keyword and the corresponding syslog level for the syslog port alert group.

Table 9: Severity and syslog Level Mapping

Call Home Level	Keyword	syslog Level	Description
9	Catastrophic	Not-Applicable	Network-wide catastrophic failure.
8	Disaster	Not-Applicable	Significant network impact.

Call Home Level	Keyword	syslog Level	Description
7	Fatal	Emergency (0)	System is unusable.
6	Critical	Alert (1)	Critical conditions that indicate that immediate attention is needed.
5	Major	Critical (2)	Major conditions.
4	Minor	Error (3)	Minor conditions.
3	Warning	Warning (4)	Warning conditions.
2	Notification	Notice (5)	Basic notification and informational messages. Possibly independently insignificant.
1	Normal	Information (6)	Normal event signifying return to normal state.
	Debugging	Debug (7)	Debugging messages.

Associating an Alert Group with a Destination Profile

An alert is sent only to destination profiles that have subscribed to the Call Home alert group.

Before you begin

Use the **show call-home alert-group** command to view available alert groups.

Step 1 **configure**

Example:

```
RP/0/RP0/CPU0:router# configure
```

Enters mode.

Step 2 **call-home**

Example:

```
RP/0/RP0/CPU0:router(config)# call-home
RP/0/RP0/CPU0:router(config-call-home)#
```

Enters call home configuration mode.

Step 3 **profile** *profile-name*

Example:

```
RP/0/RP0/CPU0:router(config-call-home)# profile my_profile
RP/0/RP0/CPU0:router(config-call-home-profile)#
```

Enters call home profile configuration mode to configure a new or existing profile.

Step 4 **subscribe-to-alert-group inventory** [**periodic** {**daily** | **monthly** *day-of-month* | **weekly** *day-of-week*} *hh:mm*

Example:

```
RP/0/RP0/CPU0:router(config-call-home-profile)# subscribe-to-alert-group
inventory periodic monthly 1 10:00
```

Configures a destination profile to receive messages for the inventory alert group. Either alerts are sent periodically, or any non-normal event triggers an alert.

Step 5 **subscribe-to-alert-group syslog severity** *severity-level* **pattern** *string*

Example:

```
RP/0/RP0/CPU0:router(config-call-home-profile)# subscribe-to-alert-group
syslog severity major pattern
```

Configures a destination profile to receive messages for the syslog alert group. Alerts with a severity the same or greater than the specified severity level are sent.

- **catastrophic**—Includes network-wide catastrophic events in the alert. This is the highest severity.
- **critical**—Includes events requiring immediate attention (system log level 1).
- **disaster**—Includes events with significant network impact.
- **fatal**—Includes events where the system is unusable (system log level 0).
- **major**—Includes events classified as major conditions (system log level 2).
- **minor**—Includes events classified as minor conditions (system log level 3)
- **normal**—Specifies the normal state and includes events classified as informational (system log level 6). This is the default.
- **notification**—Includes events informational message events (system log level 5).
- **warning**—Includes events classified as warning conditions (system log level 4).

You can specify a pattern to be matched in the syslog message. If the pattern contains spaces, you must enclose it in quotes ("").

Step 6 **subscribe-to-alert-group snapshot severity** *severity-level* **pattern** *string*

Example:

```
RP/0/RP0/CPU0:router(config-call-home-profile)# subscribe-to-alert-group
snapshot severity major pattern
```

Configures a destination profile to receive messages for the snapshot alert group. Alerts with a severity the same or greater than the specified severity level are sent.

You can specify a pattern to be matched in the syslog message. If the pattern contains spaces, you must enclose it in quotes ("").

Step 7 **subscribe-to-alert-group configuration severity** *severity-level* **pattern** *string*

Example:

```
RP/0/RP0/CPU0:router(config-call-home-profile)# subscribe-to-alert-group configuration severity major
 pattern
```

Configures a destination profile to receive messages for the configuration alert group. Alerts with a severity the same or greater than the specified severity level are sent.

You can specify a pattern to be matched in the syslog message. If the pattern contains spaces, you must enclose it in quotes ("").

Step 8 Use the **commit** or **end** command.

commit —Saves the configuration changes and remains within the configuration session.

end —Prompts user to take one of these actions:

- **Yes** — Saves configuration changes and exits the configuration session.
- **No** —Exits the configuration session without committing the configuration changes.
- **Cancel** —Remains in the configuration session, without committing the configuration changes.

What to do next

Use the **show call-home profile** command to view the profile configurations.

Configuring Email

If Call Home messages are sent via email, the you must configure your email server before Call Home messages can be sent.

Step 1 **configure**

Example:

```
RP/0/RP0/CPU0:router# configure
```

Enters mode.

Step 2 **call-home**

Example:

```
RP/0/RP0/CPU0:router(config)# call-home
RP/0/RP0/CPU0:router(config-call-home)#
```

Enters call home configuration mode.

Step 3 (Optional) **sender from** *email-address*

Example:

```
RP/0/RP0/CPU0:router(config-call-home)# sender from
my_email@cisco.com
```

Specifies the email message “from” address.

Step 4 (Optional) **sender reply-to** *email-address*

Example:

```
RP/0/RP0/CPU0:router(config-call-home)# sender reply-to
my_email@cisco.com
```

Specifies the email message “reply-to” address.

Step 5 Required: **mail-server** *address* **priority** *priority*

Example:

```
RP/0/RP0/CPU0:router(config-call-home)# mail-server
198.61.170.16 priority 1
```

Specifies the mail server to use to send Call Home messages. You can specify an IP address or mail server name. You can specify up to five mail servers to use. The server with the lower priority is tried first.

Step 6 Use the **commit** or **end** command.

commit —Saves the configuration changes and remains within the configuration session.

end —Prompts user to take one of these actions:

- **Yes** — Saves configuration changes and exits the configuration session.
- **No** —Exits the configuration session without committing the configuration changes.
- **Cancel** —Remains in the configuration session, without committing the configuration changes.

Step 7 **show call-home mail-server status**

Example:

```
RP/0/RP0/CPU0:router# show call-home mail-server status
```

Displays the status of the specified mail server.

Configuring a HTTPS Proxy Server

This task enables the user to configure a HTTPS Proxy Server.

Step 1 **configure**

Example:

```
RP/0/RP0/CPU0:router# configure
```

Enters mode.

Step 2 **call-home**

Example:

```
RP/0/RP0/CPU0:router (config) # call-home
```

Enters Call Home configuration mode.

Step 3 **http-proxy** *proxy-server-name* **port** *port-number*

Example:

```
RP/0/RP0/CPU0:router (config) # http-proxy p1 port 100
```

Configures the port for the specified HTTPS proxy server. Range is 1 to 65535.

Sending Call-home Data through an Email

This task enables the user to configure sending Call-home data using email as the transport method:

Step 1 **configure**

Example:

```
RP/0/RP0/CPU0:router# configure
```

Enters mode.

Step 2 **call-home**

Example:

```
RP/0/RP0/CPU0:router (config) # call-home
```

Enters Call Home configuration mode.

Step 3 **profile** *name*

Example:

```
RP/0/RP0/CPU0:router (config-call-home) # profile user1
```

Enters call home destination profile configuration mode for the specified destination profile name. If the specified destination profile does not exist, it is created.

Step 4 **active**

Example:

```
RP/0/RP0/CPU0:router (config-call-home-profile) # active
```

Enables the destination profile. By default, a user-defined profile is enabled when it is created.

Step 5 **destination transport-method email**

Example:

```
RP/0/RP0/CPU0:router (config-call-home-profile) # destination transport-method email
```

Configures the message transport method for email. This is the default

Step 6 **destination address email** *email-address*

Example:

```
RP/0/RP0/CPU0:router (config-call-home-profile) # destination address email xyz@cisco.com
```

Configures the destination e-mail address to which Call Home messages are sent.

Step 7 **destination preferred-msg-format {long-text |short-text| xml}**

Example:

```
RP/0/RP0/CPU0:router (config-call-home-profile) # destinationpreferred-msg-format xml
```

(Optional) Configures a preferred message format. The default is XML.

Step 8 **subscribe-to-alert-group syslog severity** *severity-level* **pattern** *string*

Example:

```
RP/0/RP0/CPU0:router (config-call-home-profile) # subscribe-to-alert-group syslog severity normal
pattern COUNT
```

Configures a destination profile to receive messages for the syslog alert group. Alerts with a severity the same or greater than the specified severity level are sent.

- **critical**—Includes events requiring immediate attention (system log level 1).
- **disaster**—Includes events with significant network impact.
- **fatal**—Includes events where the system is unusable (system log level 0).
- **major**—Includes events classified as major conditions (system log level 2).
- **minor**—Includes events classified as minor conditions (system log level 3).
- **normal**—Specifies the normal state and includes events classified as informational (system log level 6).

  This is the default.
- **notification**—Includes events informational message events (system log level 5).
- **warning**—Includes events classified as warning conditions (system log level 4).

You can specify a pattern to be matched in the syslog message. If the pattern contains spaces, you must enclose it in quotes ("").

Step 9 Use the **commit** or **end** command.

commit —Saves the configuration changes and remains within the configuration session.

end —Prompts user to take one of these actions:

- **Yes** — Saves configuration changes and exits the configuration session.
- **No** —Exits the configuration session without committing the configuration changes.
- **Cancel** —Remains in the configuration session, without committing the configuration changes.

Sending Call-home Data through HTTPS

This task enables the user to configure sending Call-home data using HTTPS as the transport method:

Note For the HTTPS function to work you should use the **crypto ca trustpoint** command to declare a CA, followed by the **crl option** command. This ensures that the certificates of other peers are accepted without trying to obtain the appropriate CRL. For example:

```
RP/0/RP0/CPU0:ios(config)#crypto ca trustpoint Trustpool
RP/0/RP0/CPU0:ios(config-trustp)#crl optional
```

Step 1 **configure**

Example:

```
RP/0/RP0/CPU0:router# configure
```

Enters mode.

Step 2 **call-home**

Example:

```
RP/0/RP0/CPU0:router (config) # call-home
```

Enters Call Home configuration mode.

Step 3 **profile** *name*

Example:

```
RP/0/RP0/CPU0:router (config-call-home) # profile user1
```

Enters call home destination profile configuration mode for the specified destination profile name. If the specified destination profile does not exist, it is created.

Step 4 **active**

Example:

```
RP/0/RP0/CPU0:router (config-call-home-profile) # active
```

Enables the destination profile. By default, a user-defined profile is enabled when it is created.

Step 5 **destination transport-method http**

Example:

```
RP/0/RP0/CPU0:router (config-call-home-profile) # destination transport-method http
```

Configures the message transport method for HTTPS.

Step 6 **destination address http** *url*

Example:

```
RP/0/RP0/CPU0:router (config-call-home-profile) # destination address http https://example.com
```

Configures the destination URL address to which Call Home messages are sent.

Step 7 **destination preferred-msg-format {long-text |short-text| xml}**

Example:

```
RP/0/RP0/CPU0:router (config-call-home-profile) # destinationpreferred-msg-format xml
```

(Optional) Configures a preferred message format. The default is XML.

Step 8 **subscribe-to-alert-group syslog severity** *severity-level* **pattern** *string*

Example:

```
RP/0/RP0/CPU0:router (config-call-home-profile) # subscribe-to-alert-group syslog severity normal
pattern COUNT
```

Configures a destination profile to receive messages for the syslog alert group. Alerts with a severity the same or greater than the specified severity level are sent.

- **critical**—Includes events requiring immediate attention (system log level 1).
- **disaster**—Includes events with significant network impact.
- **fatal**—Includes events where the system is unusable (system log level 0).
- **major**—Includes events classified as major conditions (system log level 2).
- **minor**—Includes events classified as minor conditions (system log level 3).
- **normal**—Specifies the normal state and includes events classified as informational (system log level 6).

  This is the default.
- **notification**—Includes events informational message events (system log level 5).
- **warning**—Includes events classified as warning conditions (system log level 4).

You can specify a pattern to be matched in the syslog message. If the pattern contains spaces, you must enclose it in quotes ("").

Step 9 Use the **commit** or **end** command.

commit —Saves the configuration changes and remains within the configuration session.

end —Prompts user to take one of these actions:

- **Yes** — Saves configuration changes and exits the configuration session.
- **No** —Exits the configuration session without committing the configuration changes.
- **Cancel** —Remains in the configuration session, without committing the configuration changes.

Configuring Call Home to use VRF

Step 1 **configure**

Example:

```
RP/0/RP0/CPU0:router# configure
```

Enters mode.

Step 2 **call-home**

Example:

```
RP/0/RP0/CPU0:router (config) # call-home
```

Enters Call Home configuration mode.

Step 3 **vrf** *vrf-name*

Example:

```
RP/0/RP0/CPU0:router (config-call-home) # vrf v1
```

Configures call home for the specified VRF. VRF works only for the http transport method. It does not work for the email transport method.

Configuring Call Home Data Privacy

Step 1 **configure**

Example:

```
RP/0/RP0/CPU0:router# configure
```

Enters mode.

Step 2 **call-home**

Example:

```
RP/0/RP0/CPU0:router(config) #  call-home
```

Enters the call home configuration submode.

Step 3 **data-privacy** { **level** { **normal** | **high** } | **hostname** }

Example:

```
RP/0/RP0/CPU0:router(config-call-home) # data-privacy level high
```

Scrubs data from call-home message to protect the privacy of the user. The default data-privacy level is normal.

- **normal** - scrubs all normal level commands , such as , password/ username/ ip/ destination.
- **high** - scrubs all normal level commands plus the IP domain name and IP address commands.
- **hostname** - scrubs all high-level or normal-level commands plus the hostname command. It may cause Smart Call Home processing failure.

Note Enabling the data-privacy command can affect CPU utilization when scrubbing a large amount of data.

Sending Smart License Data

This task enables the user to configure sending Smart License data through HTTPS transport method in TAC or user-defined profile:

Step 1 **configure**

Example:

```
RP/0/RP0/CPU0:router# configure
```

Enters mode.

Step 2 **call-home**

Example:

```
RP/0/RP0/CPU0:router (config) # call-home
```

Enters Call Home configuration mode.

Step 3 **profile** *name*

Perform either one of the below actions:

- For sending Smart License data in TAC profile:

  ```
  RP/0/RP0/CPU0:router (config-call-home) # profile CiscoTAC-1
  ```

- For sending Smart License data in user-defined profile:

  ```
  RP/0/RP0/CPU0:router (config-call-home) # profile user1
  ```

Step 4 **active**

Example:

```
RP/0/RP0/CPU0:router (config-call-home-profile) # active
```

Enables the destination profile. By default, a user-defined profile is enabled when it is created.

Step 5 **reporting smart-licensing-data**

Example:

```
RP/0/RP0/CPU0:router (config-call-home-profile) # reporting smart-licensing-data
```

Enables sending Smart Licensing data.

Step 6 **destination transport-method http**

Example:

```
RP/0/RP0/CPU0:router (config-call-home-profile) # destination transport-method http
```

Configures the message transport method for HTTPS.

Step 7 **destination address http** *url*

Example:

```
RP/0/RP0/CPU0:router (config-call-home-profile) # destination address http https://example.com
```

Configures the destination HTTPS address to which Smart License data is sent.

Step 8 **destination preferred-msg-format {long-text |short-text| xml}**

Example:

```
RP/0/RP0/CPU0:router (config-call-home-profile) # destinationpreferred-msg-format xml
```

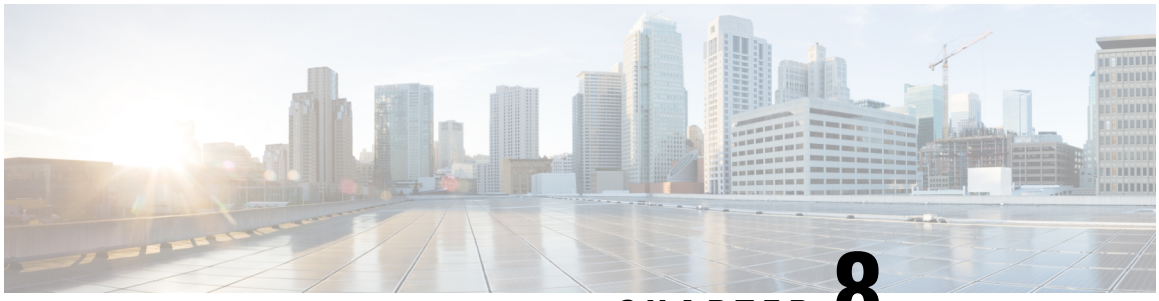
(Optional) Configures a preferred message format. The default is XML.

Step 9 Use the **commit** or **end** command.

commit —Saves the configuration changes and remains within the configuration session.

end —Prompts user to take one of these actions:

- **Yes** — Saves configuration changes and exits the configuration session.
- **No** —Exits the configuration session without committing the configuration changes.
- **Cancel** —Remains in the configuration session, without committing the configuration changes.



CHAPTER 8

Configuring Network Time Protocol

Prerequisites for Implementing NTP on Cisco IOS XR Software

You must be in a user group associated with a task group that includes the proper task IDs. The command reference guides include the task IDs required for each command. If you suspect user group assignment is preventing you from using a command, contact your AAA administrator for assistance.

Information About Implementing NTP

NTP synchronizes timekeeping among a set of distributed time servers and clients. This synchronization allows events to be correlated when system logs are created and other time-specific events occur.

NTP uses the User Datagram Protocol (UDP) as its transport protocol. All NTP communication uses Coordinated Universal Time (UTC). An NTP network usually receives its time from an authoritative time source, such as a radio clock or an atomic clock attached to a time server. NTP distributes this time across the network. NTP is extremely efficient; no more than one packet per minute is necessary to synchronize two machines to within a millisecond of each other.

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, a “stratum 2” time server receives its time via NTP from a “stratum 1” time server, and so on.

NTP avoids synchronizing to a machine whose time may not be accurate, in two ways. First, NTP never synchronizes to a machine that is not synchronized itself. Second, NTP compares the time reported by several machines and does not synchronize to a machine whose time is significantly different than the others, even if its stratum is lower. This strategy effectively builds a self-organizing tree of NTP servers.

The Cisco implementation of NTP does not support stratum 1 service; in other words, it is not possible to connect to a radio or atomic clock (for some specific platforms, however, you can connect a GPS time-source device). We recommend that time service for your network be derived from the public NTP servers available in the IP Internet.

If the network is isolated from the Internet, the Cisco implementation of NTP allows a machine to be configured so that it acts as though it is synchronized via NTP, when in fact it has determined the time using other means. Other machines can then synchronize to that machine via NTP.

Several manufacturers include NTP software for their host systems, and a publicly available version for systems running UNIX and its various derivatives is also available. This software also allows UNIX-derivative servers to acquire the time directly from an atomic clock, which would subsequently propagate time information along to Cisco routers.

The communications between machines running NTP (known as *associations*) are usually statically configured; each machine is given the IP address of all machines with which it should form associations. Accurate timekeeping is made possible by exchanging NTP messages between each pair of machines with an association.

In a LAN environment, NTP can be configured to use IP broadcast messages. As compared to polling, IP broadcast messages reduce configuration complexity, because each machine can simply be configured to send or receive broadcast or multicast messages. However, the accuracy of timekeeping is marginally reduced because the information flow is one-way only.

An NTP broadcast client listens for broadcast messages sent by an NTP broadcast server at a designated IPv4 address. The client synchronizes the local clock using the first received broadcast message.

The time kept on a machine is a critical resource, so we strongly recommend that you use the security features of NTP to avoid the accidental or malicious setting of incorrect time. Two mechanisms are available: an access list-based restriction scheme and an encrypted authentication mechanism.

When multiple sources of time (VINES, hardware clock, manual configuration) are available, NTP is always considered to be more authoritative. NTP time overrides the time set by any other method.

Preventing Issues due to GPS Week Number Rollover (WNRO)

- If there are no GPS sources in the NTP source chain or server chain, there is no impact of GPS Week Number Rollover (WNRO).
- GPS WNRO affects only the system clock and not user traffic.
- Contact your GPS manufacturer to fix the GPS source for this condition.

To mitigate impact of GPS sources that are subject to GPS WNRO perform the following optional workarounds:

- If the GPS source has been identified to be a cause of potential disruption on April 6, 2019 (or after), configure ntp master in the Cisco that is device connected to this source, and its clock on the Stratum 1 device to preventively isolate it. This configuration enables the device to present its own clock for synchronization to downstream NTP clients.

Note The usage of ntp master command as mentioned above is only a workaround to this condition. Use this command until the GPS source-related conditions are resolved, and to prevent the distribution of incorrect clock values throughout the network.

- Configure multiple NTP servers (ideally 4, but more than 3) at Stratum 2 level of the network, to enable NTP clients at Stratum 2 level to get clock from more than one Stratum 1 server. This way, WNRO affected Stratum 1 servers are staged to be marked as ‘false ticker’ or ‘outlier’ clock sources as compared to other non-WNRO affected Stratum 1 servers.

How to Implement NTP

Configuring Poll-Based Associations

Note No specific command enables NTP; the first NTP configuration command that you issue enables NTP.

You can configure the following types of poll-based associations between the router and other devices (which may also be routers):

- Client mode
- Symmetric active mode

The client and the symmetric active modes should be used when NTP is required to provide a high level of time accuracy and reliability.

When a networking device is operating in the client mode, it polls its assigned time serving hosts for the current time. The networking device then picks a host from all the polled time servers to synchronize with. Because the relationship that is established in this case is a client-host relationship, the host does not capture or use any time information sent by the local client device. This mode is most suited for file-server and workstation clients that are not required to provide any form of time synchronization to other local clients. Use the **server** command to individually specify the time-serving hosts that you want your networking device to consider synchronizing with and to set your networking device to operate in the client mode.

When a networking device is operating in the symmetric active mode, it polls its assigned time-serving hosts for the current time and it responds to polls by its hosts. Because this is a peer-to-peer relationship, the host also retains time-related information about the local networking device that it is communicating with. This mode should be used when there are several mutually redundant servers that are interconnected via diverse network paths. Most stratum 1 and stratum 2 servers on the Internet today adopt this form of network setup. Use the **peer** command to individually specify the time-serving hosts that you want your networking device to consider synchronizing with and to set your networking device to operate in the symmetric active mode.

When the router polls several other devices for the time, the router selects one device with which to synchronize.

Note To configure a peer-to-peer association between the router and another device, you must also configure the router as a peer on the other device.

You can configure multiple peers and servers, but you cannot configure a single IP address as both a peer and a server at the same time.

To change the configuration of a specific IP address from peer to server or from server to peer, use the **no** form of the **peer** or **server** command to remove the current configuration before you perform the new configuration. If you do not remove the old configuration before performing the new configuration, the new configuration does not overwrite the old configuration.

Step 1 **configure**

Example:

```
RP/0/RP0/CPU0:router# configure
```

Enters mode.

Step 2 **ntp**

Example:

```
RP/0/RP0/CPU0:router(config)# ntp
```

Enters NTP configuration mode.

Step 3 **server** *ip-address* [**version** *number*] [**key** *key-id*] [**minpoll** *interval*] [**maxpoll** *interval*] [**source** *type interface-path-id*] [**prefer**] [**burst**] [**iburst**]

Example:

```
RP/0/RP0/CPU0:router(config-ntp)# server 172.16.22.44
    minpoll 8 maxpoll 12
```

Forms a server association with another system. This step can be repeated as necessary to form associations with multiple devices.

Step 4 **peer** *ip-address* [**version** *number*] [**key** *key-id*] [**minpoll** *interval*] [**maxpoll** *interval*] [**source** *type interface-path-id*] [**prefer**]

Example:

```
RP/0/RP0/CPU0:router(config-ntp)# peer 192.168.22.33
    minpoll 8 maxpoll 12 source hundredGigE 0/0/0/1
```

Forms a peer association with another system. This step can be repeated as necessary to form associations with multiple systems.

Note To complete the configuration of a peer-to-peer association between the router and the remote device, the router must also be configured as a peer on the remote device.

Step 5 Use one of the following commands:

- **end**
- **commit**

Example:

```
RP/0/RP0/CPU0:router(config-ntp)# end
```

or

```
RP/0/RP0/CPU0:router(config-ntp)# commit
```

Saves configuration changes.

- When you issue the **end** command, the system prompts you to commit changes:

```
Uncommitted changes found, commit them before
  exiting(yes/no/cancel)?
[cancel]:
```

- Entering **yes** saves configuration changes to the running configuration file, exits the configuration session, and returns the router to EXEC mode.
- Entering **no** exits the configuration session and returns the router to EXEC mode without committing the configuration changes.
- Entering **cancel** leaves the router in the current configuration session without exiting or committing the configuration changes.

- Use the **commit** command to save the configuration changes to the running configuration file and remain within the configuration session.

Configuring Broadcast-Based NTP Associates

In a broadcast-based NTP association, an NTP server propagates NTP broadcast packets throughout a network. Broadcast clients listen for the NTP broadcast packets propagated by the NTP server and do not engage in any polling.

Broadcast-based NTP associations should be used when time accuracy and reliability requirements are modest and if your network is localized and has a large number of clients (more than 20). Broadcast-based NTP associations also are recommended for use on networks that have limited bandwidth, system memory, or CPU resources. Time accuracy is marginally reduced in broadcast-based NTP associations because information flows only one way.

Use the **broadcast client** command to set your networking device to listen for NTP broadcast packets propagated through a network. For broadcast client mode to work, the broadcast server and its clients must be located on the same subnet. The time server that is transmitting NTP broadcast packets must be enabled on the interface of the given device using the **broadcast** command.

Use the **broadcast** command to set your networking device to send NTP broadcast packets.

Note No specific command enables NTP; the first NTP configuration command that you issue enables NTP.

Step 1 **configure**

Example:

```
RP/0/RP0/CPU0:router# configure
```

Enters mode.

Step 2 **ntp**

Example:

```
RP/0/RP0/CPU0:router(config)# ntp
```

Enters NTP configuration mode.

Step 3 (Optional) **broadcastdelay** *microseconds*

Example:

```
RP/0/RP0/CPU0:router(config-ntp)# broadcastdelay 5000
```

Adjusts the estimated round-trip delay for NTP broadcasts.

Step 4 **interface** *type interface-path-id*

Example:

```
RP/0/RP0/CPU0:router(config-ntp)# interface POS 0/1/0/0
```

Enters NTP interface configuration mode.

Step 5 **broadcast client**

Example:

```
RP/0/RP0/CPU0:router(config-ntp-int)# broadcast client
```

Configures the specified interface to receive NTP broadcast packets.

Note Go to next step to configure the interface to send NTP broadcast packets.

Step 6 **broadcast** [**destination** *ip-address*] [**key** *key-id*] [**version** *number*]

Example:

```
RP/0/RP0/CPU0:router(config-ntp-int)# broadcast
destination 10.50.32.149
```

Configures the specified interface to send NTP broadcast packets.

Note Go to previous step to configure the interface to receive NTP broadcast packets.

Step 7 Use one of the following commands:

- **end**
- **commit**

Example:

```
RP/0/RP0/CPU0:router(config-ntp-int)# end
```

or

```
RP/0/RP0/CPU0:router(config-ntp-int)# commit
```

Saves configuration changes.

- When you issue the **end** command, the system prompts you to commit changes:

```
Uncommitted changes found, commit them before exiting(yes/no/cancel)?
[cancel]:
```

  - Entering **yes** saves configuration changes to the running configuration file, exits the configuration session, and returns the router to EXEC mode.
  - Entering **no** exits the configuration session and returns the router to EXEC mode without committing the configuration changes.

- Entering **cancel** leaves the router in the current configuration session without exiting or committing the configuration changes.

- Use the **commit** command to save the configuration changes to the running configuration file and remain within the configuration session.

Configuring NTP Access Groups

Note No specific command enables NTP; the first NTP configuration command that you issue enables NTP.

The access list-based restriction scheme allows you to grant or deny certain access privileges to an entire network, a subnet within a network, or a host within a subnet.

The access group options are scanned in the following order, from least restrictive to most restrictive:

1. **peer**—Allows time requests and NTP control queries and allows the system to synchronize itself to a system whose address passes the access list criteria.
2. **serve**—Allows time requests and NTP control queries, but does not allow the system to synchronize itself to a system whose address passes the access list criteria.
3. **serve-only**—Allows only time requests from a system whose address passes the access list criteria.
4. **query-only**—Allows only NTP control queries from a system whose address passes the access list criteria.

If the source IP address matches the access lists for more than one access type, the first type is granted. If no access groups are specified, all access types are granted to all systems. If any access groups are specified, only the specified access types are granted.

For details on NTP control queries, see RFC 1305 (NTP version 3).

Step 1 **configure**

Example:

```
RP/0/RP0/CPU0:router# configure
```

Enters mode.

Step 2 **ntp**

Example:

```
RP/0/RP0/CPU0:router(config)# ntp
```

Enters NTP configuration mode.

Step 3 **access-group**{**peer** | **query-only** | **serve** | **serve-only**} *access-list-name*

Example:

```
RP/0/RP0/CPU0:router(config-ntp)# access-group peer access1
```

Creates an access group and applies a basic IPv4 or IPv6 access list to it.

Step 4 Use one of the following commands:

- **end**
- **commit**

Example:

```
RP/0/RP0/CPU0:router(config-ntp)# end
```

or

```
RP/0/RP0/CPU0:router(config-ntp)# commit
```

Saves configuration changes.

- When you issue the **end** command, the system prompts you to commit changes:

```
Uncommitted changes found, commit them before
  exiting(yes/no/cancel)?
[cancel]:
```

  - Entering **yes** saves configuration changes to the running configuration file, exits the configuration session, and returns the router to EXEC mode.
  - Entering **no** exits the configuration session and returns the router to EXEC mode without committing the configuration changes.
  - Entering **cancel** leaves the router in the current configuration session without exiting or committing the configuration changes.

- Use the **commit** command to save the configuration changes to the running configuration file and remain within the configuration session.

Configuring NTP Authentication

This task explains how to configure NTP authentication.

The encrypted NTP authentication scheme should be used when a reliable form of access control is required. Unlike the access-list-based restriction scheme that is based on IP addresses, the encrypted authentication scheme uses authentication keys and an authentication process to determine if NTP synchronization packets sent by designated peers or servers on a local network are deemed as trusted, before the time information that it carries along is accepted.

The authentication process begins from the moment an NTP packet is created. A message authentication code (MAC) is computed using the MD5 Message Digest Algorithm and the MAC is embedded into an NTP synchronization packet. The NTP synchronization packet together with the embedded MAC and key number are transmitted to the receiving client. If authentication is enabled and the key is trusted, the receiving client computes the MAC in the same way. If the computed MAC matches the embedded MAC, the system is allowed to sync to the server that uses this key in its packets.

After NTP authentication is properly configured, your networking device only synchronizes with and provides synchronization to trusted time sources.

Step 1 **configure**

Example:

```
RP/0/RP0/CPU0:router# configure
```

Enters mode.

Step 2 **ntp**

Example:

```
RP/0/RP0/CPU0:router(config)# ntp
```

Enters NTP configuration mode.

Step 3 **authenticate**

Example:

```
RP/0/RP0/CPU0:router(config-ntp)# authenticate
```

Enables the NTP authentication feature.

Step 4 **authentication-key** *key-number* **md5** [**clear** | **encrypted**] *key-name*

Example:

```
RP/0/RP0/CPU0:router(config-ntp)# authentication-key 42
md5 clear key1
```

Defines the authentication keys.

- Each key has a key number, a type, a value, and, optionally, a name. Currently the only key type supported is **md5**.

Step 5 **trusted-key** *key-number*

Example:

```
RP/0/RP0/CPU0:router(config-ntp)# trusted-key 42
```

```
Defines trusted authentication keys.
```

- If a key is trusted, this router only synchronizes to a system that uses this key in its NTP packets.

Step 6 Use one of the following commands:

- **end**
- **commit**

Example:

```
RP/0/RP0/CPU0:router(config-ntp)# end
```

or

```
RP/0/RP0/CPU0:router(config-ntp)# commit
```

Saves configuration changes.

- When you issue the **end** command, the system prompts you to commit changes:

```
Uncommitted changes found, commit them before
  exiting(yes/no/cancel)?
[cancel]:
```

  - Entering **yes** saves configuration changes to the running configuration file, exits the configuration session, and returns the router to EXEC mode.
  - Entering **no** exits the configuration session and returns the router to EXEC mode without committing the configuration changes.
  - Entering **cancel** leaves the router in the current configuration session without exiting or committing the configuration changes.

- Use the **commit** command to save the configuration changes to the running configuration file and remain within the configuration session.

Disabling NTP Services on a Specific Interface

NTP services are disabled on all interfaces by default.

NTP is enabled globally when any NTP commands are entered. You can selectively prevent NTP packets from being received through a specific interface by turning off NTP on a given interface.

Step 1 **configure**

Example:

```
RP/0/RP0/CPU0:router# configure
```

Enters mode.

Step 2 **ntp**

Example:

```
RP/0/RP0/CPU0:router(config)# ntp
```

Enters NTP configuration mode.

Step 3 Use one of the following commands:

- **no interface** *type interface-path-id*
- **interface** *type interface-path-id* **disable**

Example:

```
RP/0/RP0/CPU0:router(config-ntp)# no interface pos 0/0/0/1
```

or

```
RP/0/RP0/CPU0:router(config-ntp)# interface POS 0/0/0/1 disable
```

Disables NTP services on the specified interface.

Step 4 Use one of the following commands:

- **end**
- **commit**

Example:

```
RP/0/RP0/CPU0:router(config-ntp)# end
```

or

```
RP/0/RP0/CPU0:router(config-ntp)# commit
```

Saves configuration changes.

- When you issue the **end** command, the system prompts you to commit changes:

```
Uncommitted changes found, commit them before
  exiting(yes/no/cancel)?
[cancel]:
```

  - Entering **yes** saves configuration changes to the running configuration file, exits the configuration session, and returns the router to EXEC mode.
  - Entering **no** exits the configuration session and returns the router to EXEC mode without committing the configuration changes.
  - Entering **cancel** leaves the router in the current configuration session without exiting or committing the configuration changes.

- Use the **commit** command to save the configuration changes to the running configuration file and remain within the configuration session.

Configuring the Source IP Address for NTP Packets

By default, the source IP address of an NTP packet sent by the router is the address of the interface through which the NTP packet is sent. Use this procedure to set a different source address.

Step 1 **configure**

Example:

```
RP/0/RP0/CPU0:router# configure
```

Enters mode.

Step 2 **ntp**

Example:

```
RP/0/RP0/CPU0:router(config)# ntp
```

Enters NTP configuration mode.

Step 3 **source** *type interface-path-id*

Example:

```
RP/0/RP0/CPU0:router(config-ntp)# source POS 0/0/0/1
```

Configures an interface from which the IP source address is taken.

Note This interface is used for the source address for all packets sent to all destinations. If a source address is to be used for a specific association, use the **source** keyword in the **peer** or **server** command shown in Configuring Poll-Based Associations, on page 83.

Step 4 Use one of the following commands:

- **end**
- **commit**

Example:

```
RP/0/RP0/CPU0:router(config-ntp)# end
```

or

```
RP/0/RP0/CPU0:router(config-ntp)# commit
```

Saves configuration changes.

- When you issue the **end** command, the system prompts you to commit changes:

```
Uncommitted changes found, commit them before
  exiting(yes/no/cancel)?
[cancel]:
```

  - Entering **yes** saves configuration changes to the running configuration file, exits the configuration session, and returns the router to EXEC mode.
  - Entering **no** exits the configuration session and returns the router to EXEC mode without committing the configuration changes.
  - Entering **cancel** leaves the router in the current configuration session without exiting or committing the configuration changes.

- Use the **commit** command to save the configuration changes to the running configuration file and remain within the configuration session.

Configuring the System as an Authoritative NTP Server

You can configure the router to act as an authoritative NTP server, even if the system is not synchronized to an outside time source.

Step 1 **configure**

Example:

```
RP/0/RP0/CPU0:router# configure
```

Enters mode.

Step 2 **ntp**

Example:

```
RP/0/RP0/CPU0:router(config)# ntp
```

Enters NTP configuration mode.

Step 3 **master** *stratum*

Example:

```
RP/0/RP0/CPU0:router(config-ntp)# master 9
Makes the router an authoritative NTP server.
```

Note Use the **master** command with caution. It is very easy to override valid time sources using this command, especially if a low stratum number is configured. Configuring multiple machines in the same network with the **master** command can cause instability in time keeping if the machines do not agree on the time.

Step 4 Use one of the following commands:

- **end**
- **commit**

Example:

```
RP/0/RP0/CPU0:router(config-ntp)# end
```

or

```
RP/0/RP0/CPU0:router(config-ntp)# commit
```

Saves configuration changes.

- When you issue the **end** command, the system prompts you to commit changes:

```
Uncommitted changes found, commit them before
  exiting(yes/no/cancel)?
[cancel]:
```

  - Entering **yes** saves configuration changes to the running configuration file, exits the configuration session, and returns the router to EXEC mode.

- Entering **no** exits the configuration session and returns the router to EXEC mode without committing the configuration changes.
- Entering **cancel** leaves the router in the current configuration session without exiting or committing the configuration changes.

- Use the **commit** command to save the configuration changes to the running configuration file and remain within the configuration session.

Updating the Hardware Clock

On devices that have hardware clocks (system calendars), you can configure the hardware clock to be periodically updated from the software clock. This is advisable for devices using NTP, because the time and date on the software clock (set using NTP) is more accurate than the hardware clock. The time setting on the hardware clock has the potential to drift slightly over time.

Step 1 **configure**

Example:

```
RP/0/RP0/CPU0:router# configure
```

Enters mode.

Step 2 **ntp**

Example:

```
RP/0/RP0/CPU0:router(config)# ntp
```

Enters NTP configuration mode.

Step 3 **update-calendar**

Example:

```
RP/0/RP0/CPU0:router(config-ntp)# update-calendar
```

Configures the router t o update its system calendar from the software clock at periodic intervals.

Step 4 Use one of the following commands:

- **end**
- **commit**

Example:

```
RP/0/RP0/CPU0:router(config-ntp)# end
```

or

```
RP/0/RP0/CPU0:router(config-ntp)# commit
```

Saves configuration changes.

- When you issue the **end** command, the system prompts you to commit changes:

```
Uncommitted changes found, commit them before
  exiting(yes/no/cancel)?
[cancel]:
```

  - Entering **yes** saves configuration changes to the running configuration file, exits the configuration session, and returns the router to EXEC mode.
  - Entering **no** exits the configuration session and returns the router to EXEC mode without committing the configuration changes.
  - Entering **cancel** leaves the router in the current configuration session without exiting or committing the configuration changes.

- Use the **commit** command to save the configuration changes to the running configuration file and remain within the configuration session.

Verifying the Status of the External Reference Clock

This task explains how to verify the status of NTP components.

Note The commands can be entered in any order.

Step 1 **show ntp associations** [**detail**] [**location** *node-id*]

Example:

```
RP/0/RP0/CPU0:router# show ntp associations
```

Displays the status of NTP associations.

Step 2 **show ntp status** [**location** *node-id*]

Example:

```
RP/0/RP0/CPU0:router# show ntp status
```

Displays the status of NTP.

NTP-PTP Interworking

Table 10: Feature History Table

Feature Name	Release Information	Feature Description
NTP-PTP Interworking	Release 7.11.1	We have improved NTP synchronization and reliability to achieve nanosecond-level accuracy for applications that require high-precision timing. This is achieved by enabling NTP-PTP interworking which allows the use of PTP as the reference clock. As in previous releases, the NTP client continues to support polling NTP protocol-based external time servers to synchronize the local system clock and achieve accuracy within the millisecond range.

Before the support of NTP-PTP interworking, only backplane time was supported for the operating system time of the router.

Starting Cisco IOS XR Software Release 7.11.1, NTP-PTP interworking provides the ability to use PTP, and other valid time of day (TOD) sources such as Data over Cable Service Interface Specification (DOCSIS) Timing Interface (DTI) and global positioning system (GPS), as the time source for the operating system in the units of nanosec level accuracy. PTP is capable of achieving nanosecond-level accuracy, while NTP is typically only accurate to within milliseconds. By using PTP as a reference clock, NTP can improve its accuracy and meet the needs of applications that require high precision timing.

NTP-PTP interworking also provides the means to communicate status changes between PTP and NTP processes. It also supports the unambiguous control of the operating system time and backplane time in the event of bootup, switchovers, or card and process failures.

With NTP-PTP interworking, NTP is less likely to lose synchronization. As, PTP is more robust to network delays and disruptions than NTP. So, if there's a problem with the network, PTP can still maintain accurate synchronization.

Prerequisites for NTP-PTP Interworking

- Ensure that PTP is enabled, before configuring NTP-PTP Interworking.

  For PTP, GM gets the clock from GPS/GNSS reference clock:

  - If PTP-NTP feature is enabled on GM node, ensure GM gets clock reference from FPS/GNSS clock reference, config CLI on GM node.
  - If PTP-NTP feature is enabled on BC node, ensure GM gets clock reference from FPS/GNSS clock reference, config CLI on BC Node.
  - If PTP-NTP feature is enabled on TSC node, ensure GM gets clock reference from FPS/GNSS clock reference, and BC node gets the clock from that GM node, TSC node gets clock from BC node, and config CLI on TSC Node.

- If GM is not connected to any GPS/GNSS ref clock, default PTP is clock is set to Jan 1, 1970.

Enable NTP-PTP Interworking

You can configure NTP-PTP Interworking in any of the following ways:

- Setting NTP Primary Reference Clock as PTP

```
Router # Configure
Router(config) # ntp
Router(config-ntp) # master primary-reference-clock
Router(config-ntp) # commit
```

- Configuring NTP Server with IP address

  The following example shows an NTP configuration to allow the system clock to be synchronized by time server hosts at IP address 198.51.100.1. You can take IP address of a neighbouring PTP interface.

```
Router # Configure terminal
Router(config)# ntp server 198.51.100.1
Router(config-ntp) # commit
```

Running Configuration

```
Router(config)#show running-config ntp
ntp
master primary-reference-clock
!

Router(config)#show running-config ntp
ntp
server 198.51.100.1
!
```

Verification

```
Router#show ntp status

Clock is synchronized, stratum 1, reference is 198.51.100.1
nominal freq is 1000000000.0000 Hz, actual freq is 101341889.2967 Hz, precision is 2**24
reference time is 8497CD13.A6AEB9DA (00:02:27.651 UTC Tue Jun 30 1970)
clock offset is -0.077 msec, root delay is 0.000 msec
root dispersion is 3937.89 msec, peer dispersion is 3937.74 msec
loopfilter state is 'CTRL' (Normal Controlled Loop), drift is 0.0000088676 s/s
system poll interval is 64, last update was 4 sec ago
authenticate is disabled, panic handling is disabled,
hostname resolution retry interval is 1440 minutes

Router#Show ntp associations
  address         ref clock     st  when  poll reach  delay  offset    disp
*~198.51.100.1    .PTP.          0     -    64    0   0.00   0.000   16000
```

FQDN for NTP Server

Table 11: Feature History Table

Feature Name	Release Information	Feature Description
FQDN for NTP Server on Non-default VRF	Release 7.9.1	You can now specify a Fully Qualified Domain Name (FQDN) as the hostname for NTP server configuration over non-default VRFs. FQDNs are easy to remember compared to numeric IP addresses. Service migration from one host to another can cause a change in IP address leading to outages. Prior releases allowed FQDN handling in only default VRFs.

NTP on Cisco IOS XR Software supports configuration of servers and peers using their Fully Qualified Domain Names (FQDN). While configuring, the FQDN is resolved via DNS into its corresponding IPv4 or IPv6 address and is stored in the running-configuration of the system. NTP supports FQDN for both IPv4 and IPv6 protocols. You can configure FQDN on default vrf.

Starting Cisco IOS XR Software Release 7.9.1 you can configure FQDN in nondefault vrf also.

Configure FQDN for NTP server

Configuration Example for FQDN on NTP Server on Default VRF

Use the **ntp server** command with the FQDN name to configure FQDN on default VRF. You dont need to specify VRF name. In the following example, *time.cisco.com* is the FQDN.

```
Router#configure
Router(config)#ntp server time.cisco.com
Router(config)#commit
```

Running Configuration

Use the **show running-config ntp** command to see the ntp running configuration.

```
Router#show running-config ntp
ntp
 server 192.0.2.1
!
```

Verification

Use the **show ntp associations** command to verify that an NTP association has come up.

```
Router#show ntp associations

      address       ref clock     st  when  poll reach  delay  offset    disp
 ~192.0.2.1       173.38.201.67    2    42   128     3  196.06  -14.25  3949.4
 * sys_peer, # selected, + candidate, - outlayer, x falseticker, ~ configured
```

Prerequisites for configuring FQDN in a nondefault VRF

- Configuration must exist for DNS resolution over that specific VRF.
- The server must be reachable.

Configuration Example for FQDN on NTP Server on Nondefault VRF

FQDN must be reachable from the router to configure it as an NTP server or peer. You can use the **ping** command and verify that FQDN is reachable. In the following example, *time.cisco.com* is the FQDN and *vrf_1* is the VRF over which it is reachable.

```
Router#ping time.cisco.com vrf vrf_1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.0.2.1 timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 171/171/172 ms
```

When you have confirmed that FQDN is reachable, you can configure FQDN to be used as an NTP server/peer.

```
Router#configure
Router(config)#ntp server vrf vrf_1 time.cisco.com minpoll 4 maxpoll 4 iburst
Router(config)#commit
```

Note If the FQDN you're trying to configure isn't reachable, the CLI treats it as invalid input.

Running Configuration

Use the **show running-config ntp** command to see the ntp running configuration.

```
Router#show running-config ntp
 ntp
  server vrf vrf_1 192.0.2.1 minpoll 4 maxpoll 4 iburst
 !
```

Verification

Use the **show ntp associations** command to verify that an NTP association has come up.

```
Router#show ntp associations
 address         ref clock     st  when  poll reach  delay  offset    disp
~192.0.2.1 vrf vrf_1
               173.38.201.115  2    14    16   37  179.10  13.492  16.680
* sys_peer, # selected, + candidate, - outlayer, x falseticker, ~ configured
```

Configuration Examples for Implementing NTP

Configuring Poll-Based Associations: Example

The following example shows an NTP configuration in which the router's system clock is configured to form a peer association with the time server host at IP address 192.168.22.33, and to allow the system clock to be synchronized by time server hosts at IP address 10.0.2.1 and 172.19.69.1:

```
ntp
  server 10.0.2.1 minpoll 5 maxpoll 7
  peer 192.168.22.33

  server 172.19.69.1
```

Configuring Broadcast-Based Associations: Example

The following example shows an NTP client configuration in which interface 0/2/0/0 is configured to receive NTP broadcast packets, and the estimated round-trip delay between an NTP client and an NTP broadcast server is set to 2 microseconds:

```
ntp
  interface hundredGigE 0/2/0/0
    broadcast client
    exit
  broadcastdelay 2
```

The following example shows an NTP server configuration where interface 0/2/0/2 is configured to be a broadcast server:

```
ntp
  interface hundredGigE 0/2/0/2
    broadcast
```

Configuring NTP Access Groups: Example

The following example shows a NTP access group configuration where the following access group restrictions are applied:

- Peer restrictions are applied to IP addresses that pass the criteria of the access list named peer-acl.
- Serve restrictions are applied to IP addresses that pass the criteria of access list named serve-acl.
- Serve-only restrictions are applied to IP addresses that pass the criteria of the access list named serve-only-acl.
- Query-only restrictions are applied to IP addresses that pass the criteria of the access list named query-only-acl.

```
ntp
  peer 10.1.1.1
  peer 10.1.1.1
  peer 10.2.2.2
  peer 10.3.3.3
  peer 10.4.4.4
  peer 10.5.5.5
  peer 10.6.6.6
  peer 10.7.7.7
  peer 10.8.8.8
  access-group peer peer-acl
  access-group serve serve-acl
```

```
  access-group serve-only serve-only-acl
  access-group query-only query-only-acl
  exit
ipv4 access-list peer-acl
  10 permit ip host 10.1.1.1 any
  20 permit ip host 10.8.8.8 any
  exit
ipv4 access-list serve-acl
  10 permit ip host 10.4.4.4 any
  20 permit ip host 10.5.5.5 any
  exit
ipv4 access-list query-only-acl
  10 permit ip host 10.2.2.2 any
  20 permit ip host 10.3.3.3 any
  exit
ipv4 access-list serve-only-acl
  10 permit ip host 10.6.6.6 any
  20 permit ip host 10.7.7.7 any
  exit
```

Configuring NTP Authentication: Example

The following example shows an NTP authentication configuration. In this example, the following is configured:

- NTP authentication is enabled.
- Two authentication keys are configured (key 2 and key 3).
- The router is configured to allow its software clock to be synchronized with the clock of the peer (or vice versa) at IP address 10.3.32.154 using authentication key 2.
- The router is configured to allow its software clock to be synchronized with the clock by the device at IP address 10.32.154.145 using authentication key 3.
- The router is configured to synchronize only to systems providing authentication key 3 in their NTP packets.

```
ntp
  authenticate
  authentication-key 2 md5 encrypted 06120A2D40031D1008124
  authentication-key 3 md5 encrypted 1311121E074110232621
  trusted-key 3
  server 10.3.32.154 key 3
  peer 10.32.154.145 key 2
```

Disabling NTP on an Interface: Example

The following example shows an NTP configuration in which 0/2/0/0 interface is disabled:

```
ntp
  interface hundredGigE 0/2/0/0
    disable
    exit
  authentication-key 2 md5 encrypted 06120A2D40031D1008124
```

```
  authentication-key 3 md5 encrypted 1311121E074110232621
  authenticate
  trusted-key 3
  server 10.3.32.154 key 3
  peer 10.32.154.145 key 2
```

Configuring the Source IP Address for NTP Packets: Example

The following example shows an NTP configuration in which Ethernet management interface 0/0/CPU0/0 is configured as the source address for NTP packets:

```
ntp
  authentication-key 2 md5 encrypted 06120A2D40031D1008124
  authentication-key 3 md5 encrypted 1311121E074110232621
  authenticate
  trusted-key 3
  server 10.3.32.154 key 3
  peer 10.32.154.145 key 2
  source MgmtEth0/0/CPU0/0
```

Configuring the System as an Authoritative NTP Server: Example

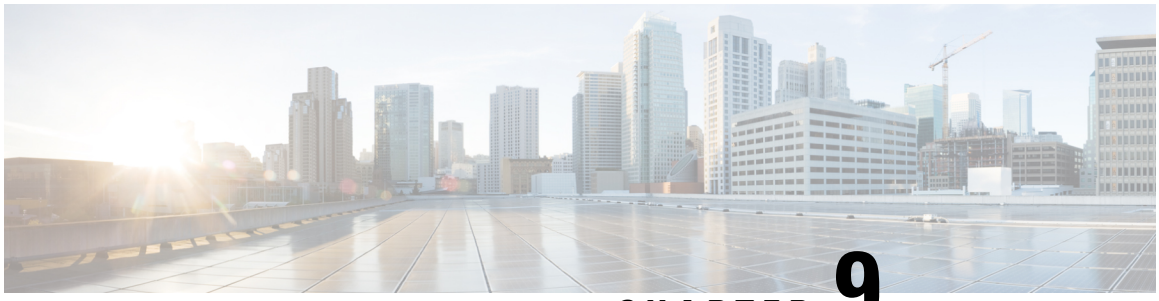
The following example shows a NTP configuration in which the router is configured to use its own NTP master clock to synchronize with peers when an external NTP source becomes unavailable:

```
ntp
  master 6
```

Updating the Hardware Clock: Example

The following example shows an NTP configuration in which the router is configured to update its hardware clock from the software clock at periodic intervals:

```
ntp
  server 10.3.32.154
  update-calendar
```



CHAPTER 9

Managing Router Hardware

This chapter describes the concepts and tasks used to manage and configure the hardware components of a router running the Cisco IOS XR software.

This module contains the following topics:

RP Redundancy and Switchover

This section describes RP redundancy and switchover commands and issues.

Establishing RP Redundancy

Your router has two slots for RPs: RP0 and RP1 (see Figure 4: Redundant Set of RP Installed in Slots RP0 and RP1 in an Cisco 8608 8-Slot Centralized Chassis, on page 104 and Figure 5: Redundant Set of RP Installed in Slots RP0 and RP1 in an Cisco 8808 8-Slot Distributed Chassis, on page 105). RP0 is the slot on the left, facing the front of the chassis, and RP1 is the slot on right. These slots are configured for redundancy by default, and the redundancy cannot be eliminated. To establish RP redundancy, install RP into both slots.

Figure 4: Redundant Set of RP Installed in Slots RP0 and RP1 in an Cisco 8608 8-Slot Centralized Chassis

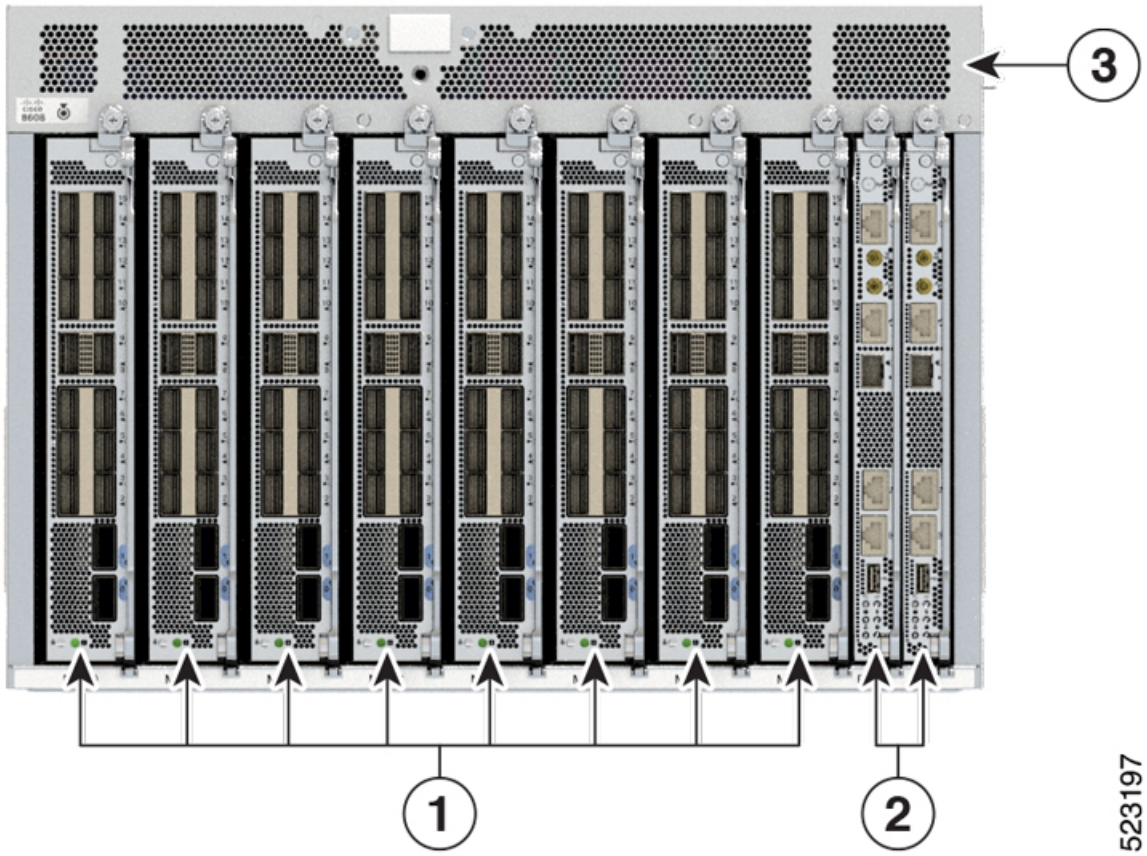
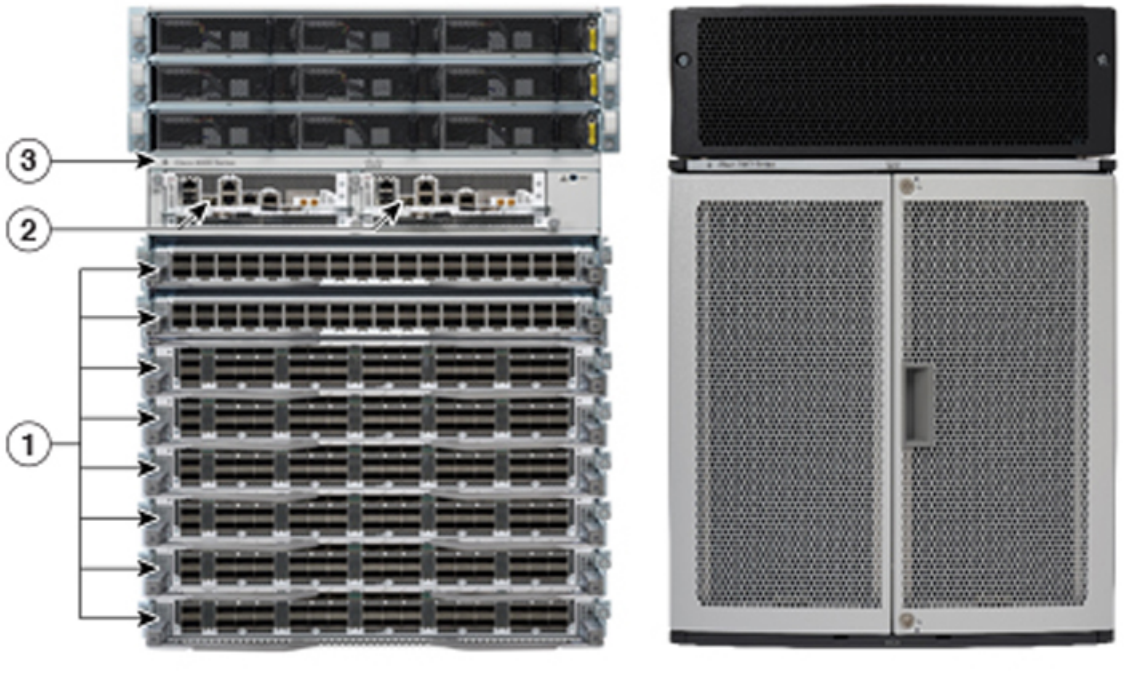


Figure 5: Redundant Set of RP Installed in Slots RP0 and RP1 in an Cisco 8808 8-Slot Distributed Chassis



1	Modular Port Adaptors (MPAs)
2	Route Processors (RPs)
3	Chassis

Determining the Active RP in a Redundant Pair

During system startup, one RP in each redundant pair becomes the active RP. You can tell which RP is the active RP in the following ways:

- The active RP can be identified by the green Active LED on the faceplate of the card. When the Active LED turns on, it indicates that the RP is active and when it turns off, it indicates that the RP is in standby.
- The slot of the active RP is indicated in the CLI prompt. For example:

```
RP/0/RP1/CPU0:router#
```

  In this example, the prompt indicates that you are communicating with the active RP in slot RP1.

- Enter the **show redundancy** command in EXEC mode to display a summary of the active and standby RP status. For example:

```
RP/0/RP0/CPU0:router# show redundancy

  This node (0/RP0/CPU0) is in ACTIVE role
  Partner node (0/RP1/CPU0) is in STANDBY role
  Standby node in 0/RP1/CPU0 is ready
```

```
Reload and boot info
----------------------
RP reloaded Fri Apr  9 03:44:28 2004: 16 hours, 51 minutes ago
This node booted Fri Apr  9 06:19:05 2004: 14 hours, 16 minutes ago
Last switch-over Fri Apr  9 06:53:18 2004: 13 hours, 42 minutes ago
Standby node boot Fri Apr  9 06:54:25 2004: 13 hours, 41 minutes ago
Standby node last not ready Fri Apr  9 20:35:23 2004: 0 minutes ago
Standby node last ready Fri Apr  9 20:35:23 2004: 0 minutes ago
There have been 2 switch-overs since reload
```

Role of the Standby RP

The second RP to boot in a redundant pair automatically becomes the standby RP. While the active RP manages the system and communicates with the user interface, the standby RP maintains a complete backup of the software and configurations for all cards in the system. If the active RP fails or goes off line for any reason, the standby RP immediately takes control of the system.

Summary of Redundancy Commands

RP redundancy is enabled by default in the Cisco IOS XR software, but you can use the commands described in Table 12: RP Redundancy Commands, on page 106 to display the redundancy status of the cards or force a manual switchover.

Table 12: RP Redundancy Commands

Command	Description
show redundancy	Displays the redundancy status of the RP. This command also displays the boot and switch-over history for the RP.
redundancy switchover	Forces a manual switchover to the standby RP. This command works only if the standby RP is installed and in the “ready” state.
show platform	Displays the status for node, including the redundancy status of the RP cards. In EXEC mode, this command displays status for the nodes assigned to the SDR. In administration EXEC mode, this command displays status for all nodes in the system.

Automatic Switchover

Automatic switchover from the active RP to the standby RP occurs only if the active RP encounters a serious system error, such as the loss of a mandatory process or a hardware failure. When an automatic switchover occurs, the RPs respond as follows:

- If a standby RP is installed and “ready” for switchover, the standby RP becomes the active RP. The original active RP attempts to reboot.
- If the standby RP is not in “ready” state, then both RPs reboot. The first RP to boot successfully assumes the role of active RP.

RP Redundancy During RP Reload

The **reload** command causes the active RP to reload the Cisco IOS XR software. When an RP reload occurs, the RPs respond as follows:

- If a standby RP is installed and "ready" for switchover, the standby RP becomes the active RP. The original active RP reboots and becomes the standby RP.
- If the standby RP is not in the "ready" state, then both RPs reboot. The first RP to boot successfully assumes the role of active RP.

Manual Switchover

If a standby RP is installed and ready for switchover, you can force a manual switchover using the **redundancy switchover** command or reloading the active RP using the **reload** command.

Manual Switchover Using the Reload Command

You can force a manual switchover from the active RP to the standby RP by reloading the active RP using the **reload** command. As active RP reboots, the current standby RP becomes active RP, and rebooting RP switches to standby RP.

```
RP/0/RP0/CPU0:router# reload
RP/0/RP1/CPU0:router#
```

Manual Switchover Using the Redundancy Switchover Command

You can force a manual switchover from the active RP to the standby RP using the **redundancy switchover** command.

If a standby RP is installed and ready for switchover, the standby RP becomes the active RP. The original active RP becomes the standby RP. In the following example, partial output for a successful redundancy switchover operation is shown:

```
RP/0/RP0/CPU0:router# show redundancy

  This node (0/RP0/CPU0) is in ACTIVE role
  Partner node (0/RP1/CPU0) is in STANDBY role
  Standby node in 0/RP1/CPU0 is ready

  RP/0/RP0/CPU0:router# redundancy switchover
  Updating Commit Database.  Please wait...[OK]
  Proceed with switchover 0/RP0/CPU0 -> 0/RP1/CPU0? [confirm]
  Initiating switch-over.
  RP/0/RP0/CPU0:router#

  <Your 'TELNET' connection has terminated>
```

In the preceding example, the Telnet connection is lost when the previously active RP resets. To continue management of the router, you must connect to the newly activated RP as shown in the following example:

```
User Access Verification

  Username: xxxxx
```

```
  Password: xxxxx
  Last switch-over Sat Apr 15 12:26:47 2009: 1 minute ago

RP/0/RP1/CPU0:router#
```

If the standby RP is not in “ready” state, the switchover operation is not allowed. In the following example, partial output for a failed redundancy switchover attempt is shown:

```
RP/0/RP0/CPU0:router# show redundancy

  Redundancy information for node 0/RP1/CPU0:
  ==========================================
  Node 0/RP0/CPU0 is in ACTIVE role
  Partner node (0/RP1/CPU0) is in UNKNOWN role

  Reload and boot info
  ----------------------
  RP reloaded Wed Mar 29 17:22:08 2009: 2 weeks, 2 days, 19 hours, 14 minutes ago
  Active node booted Sat Apr 15 12:27:58 2009: 8 minutes ago
  Last switch-over Sat Apr 15 12:35:42 2009: 1 minute ago
  There have been 4 switch-overs since reload

  RP/0/RP0/CPU0:router# redundancy switchover

  Switchover disallowed: Standby node is not ready.
```

Communicating with a Standby RP

The active RP automatically synchronizes all system software, settings, and configurations with the standby RP.

If you connect to the standby RP through the console port, you can view the status messages for the standby RP. The standby RP does not display a CLI prompt, so you cannot manage the standby card while it is in standby mode.

If you connect to the standby RP through the management Ethernet port, the prompt that appears is for the active RP, and you can manage the router the same as if you had connected through the management Ethernet port on the active RP.

NPU Power Optimization

Table 13: Feature History Table

Feature Name	Release Information	Description
NPU Power Optimization	Release 7.3.15	This feature lets you choose a predefined NPU power mode based on your network's individual requirements, and consequently reducing NPU power consumption. The **hw-module npu-power-profile** command is introduced for this feature.

Cisco 8000 series routers are powered by Cisco Silicon One Q200 and Q100 series processors. Cisco Silicon One processors offer high performance, flexible, and power-efficient routing silicon in the market.

NPU Power Optimization feature helps to reduce NPU power consumption by running a processor in a predefined mode. There are three NPU power modes—high, medium, and low. Based on your network traffic and power consumption requirements, you can choose to run the processor in any one of the three NPU power modes.

- High: The router will use the maximum amount of power, resulting in the best possible performance.
- Medium: The router power consumption and performance levels are both average.
- Low: The router operates with optimal energy efficiency while providing a modest level of performance.

Note We recommend that you work with your Cisco account representatives before implementing this feature in your network.

On a Q200-based Cisco 8200 series chassis, you can configure an NPU power mode on the entire router.

On a Q200-based Cisco 8800 series chassis, you can configure an NPU power mode only on fabric cards and line cards.

The following table lists the supported hardware, and their default NPU power mode:

Table 14: Supported Hardware and Default Modes

Supported Hardware	Default NPU Power Mode
Cisco 8200 32x400 GE 1RU fixed chassis (8201-32FH)	High
88-LC0-36FH without MACSec, based on Q200 Silicon Chip	Medium
88-LC0-36FH-M with MACSec, based on Q200 Silicon Chip	Medium
8808-FC0 Fabric Card, based on Q200 Silicon Chip	Low
8818-FC0 Fabric Card, based on Q200 Silicon Chip	Medium

Caution We recommend that you use the default NPU power mode on your router.

Limitations

The NPU power optimization is not supported on the Q100-based systems.

The NPU Power Profile mode is not supported on the following Q200-based line cards:

Table 15: Limitation on Hardware and Power Profile Modes

Hardware	Power Profile Mode
88-LC0-36FH-M	High
88-LC0-34H14FH	High

Configuring NPU Power Mode

Configuring NPU power mode on a fixed chassis:

The following example shows how to configure an NPU power mode on a fixed chassis:

```
RP/0/RP0/CPU0:ios(config)#hw-module npu-power-profile high
RP/0/RP0/CPU0:ios(config)#commit

RP/0/RP0/CPU0:ios(config)#reload
```

Note Note: Reload the chassis for the configurations changes to take effect.

Verifying NPU power mode configuration on a fixed chassis:

Use the **show controllers npu driver** command to verify the NPU power mode configuration:

```
RP/0/RP0/CPU0:ios#show controllers npu driver location 0/RP0/CPU0
Mon Aug 24 23:29:34.302 UTC
==========================================
NPU Driver Information
==========================================
Driver Version: 1
SDK Version: 1.32.0.1
Functional role: Active,     Rack: 8203, Type: lcc, Node: 0
Driver ready      : Yes
NPU first started : Mon Aug 24 23:07:41 2020
Fabric Mode:
NPU Power profile: High
Driver Scope: Node
Respawn count     : 1
Availablity masks :
        card: 0x1,     asic: 0x1,    exp asic: 0x1
...
```

Configuring NPU power mode on a modular chassis

The following example shows how to configure an NPU power mode on a fabric card and a line card:

```
RP/0/RP0/CPU0:ios(config)#hw-module npu-power-profile card-type FC high
RP/0/RP0/CPU0:ios(config)#hw-module npu-power-profile card-type LC low location 0/1/cpu0
RP/0/RP0/CPU0:ios(config)#commit
```

Note For the configurations to take effect, you must:

- Reload a line card if the configuration is applied on the line card.
- Reload a router if the configuration is applied on a fabric card.

Verifying the NPU power mode configuration on a modular chassis

Use the **show controllers npu driver location** command to verify the NPU power mode configuration:

```
RP/0/RP0/CPU0:ios#show controllers npu driver location 0/1/CPU0

Functional role: Active,     Rack: 8808, Type: lcc, Node: 0/RP0/CPU0
Driver ready      : Yes
NPU first started : Mon Apr 12 09:57:27 2021
Fabric Mode: FABRIC/8FC
NPU Power profile: High
Driver Scope: Rack
Respawn count     : 1
Availablity masks :
        card: 0xba,     asic: 0xcfcc,    exp asic: 0xcfcc
Weight distribution:
        Unicast: 80,      Multicast: 20
+-------------------------------------------------------------------+
| Process | Connection | Registration | Connection | DLL            |
| /Lib    | status     | status       | requests   | registration|
+-------------------------------------------------------------------+
| FSDB    | Active     | Active       |           1|  n/a        |
| FGID    | Active     | Active       |           1|  n/a        |
| AEL     | n/a        | n/a          |         n/a|  Yes        |
| SM      | n/a        | n/a          |         n/a|  Yes        |
+-------------------------------------------------------------------+

Asics :
HP - HotPlug event, PON - Power On reset
HR - Hard Reset,    WB  - Warm Boot
+-------------------------------------------------------------------------------------+
| Asic inst. | fap|HP|Slice|Asic|Admin|Oper | Asic state | Last |PON|HR |  FW  |
|  (R/S/A)   | id |  |state|type|state|state|            | init |(#)|(#)|  Rev |
+-------------------------------------------------------------------------------------+
| 0/FC1/2    | 202| 1| UP  |s123| UP  | UP  |NRML        |PON   |  1|  0|0x0000|
| 0/FC1/3    | 203| 1| UP  |s123| UP  | UP  |NRML        |PON   |  1|  0|0x0000|
| 0/FC3/6    | 206| 1| UP  |s123| UP  | UP  |NRML        |PON   |  1|  0|0x0000|
| 0/FC3/7    | 207| 1| UP  |s123| UP  | UP  |NRML        |PON   |  1|  0|0x0000|
| 0/FC4/8    | 208| 1| UP  |s123| UP  | UP  |NRML        |PON   |  1|  0|0x0000|
| 0/FC4/9    | 209| 1| UP  |s123| UP  | UP  |NRML        |PON   |  1|  0|0x0000|
| 0/FC5/10   | 210| 1| UP  |s123| UP  | UP  |NRML        |PON   |  1|  0|0x0000|
| 0/FC5/11   | 211| 1| UP  |s123| UP  | UP  |NRML        |PON   |  1|  0|0x0000|
| 0/FC7/14   | 214| 1| UP  |s123| UP  | UP  |NRML        |PON   |  1|  0|0x0000|
| 0/FC7/15   | 215| 1| UP  |s123| UP  | UP  |NRML        |PON   |  1|  0|0x0000|
+-------------------------------------------------------------------------------------+

SI Info :
+-------------------------------------------------------------------------------------------------+
|   Card  | Board      | SI Board | SI Param | Retimer SI    | Retimer SI    | Front Panel
   |
|         | HW Version | Version  | Version  | Board Version | Param Version | PHY
   |
+-------------------------------------------------------------------------------------------------+
```

```
|  FC1    |  0.22      |     1    |     6    |       NA      |       NA      |       NA
   |
|  FC3    |  0.21      |     1    |     6    |       NA      |       NA      |       NA
   |
|  FC4    |  0.21      |     1    |     6    |       NA      |       NA      |       NA
   |
|  FC5    |  0.21      |     1    |     6    |       NA      |       NA      |       NA
   |
|  FC7    |  0.21      |     1    |     6    |       NA      |       NA      |       NA
   |
+-------------------------------------------------------------------------------------------+
Functional role: Active,     Rack: 8808, Type: lcc, Node: 0/1/CPU0
Driver ready      : Yes
NPU first started : Mon Apr 12 09:58:10 2021
Fabric Mode: FABRIC/8FC
NPU Power profile: Low
Driver Scope: Node
Respawn count     : 1
Availablity masks :
        card: 0x1,     asic: 0x7,    exp asic: 0x7
Weight distribution:
        Unicast: 80,      Multicast: 20
+-----------------------------------------------------------------+
| Process | Connection | Registration | Connection | DLL          |
| /Lib    | status     | status       | requests   | registration|
+-----------------------------------------------------------------+
| FSDB    | Active     | Active       |           1|  n/a         |
| FGID    | Inactive   | Inactive     |           0|  n/a         |
| AEL     | n/a        | n/a          |         n/a|  Yes         |
| SM      | n/a        | n/a          |         n/a|  Yes         |
+-----------------------------------------------------------------+

Asics :
HP - HotPlug event, PON - Power On reset
HR - Hard Reset,    WB  - Warm Boot
+-------------------------------------------------------------------------------+
| Asic inst. | fap|HP|Slice|Asic|Admin|Oper | Asic state | Last |PON|HR |  FW  |
|  (R/S/A)   | id |  |state|type|state|state|            | init |(#)|(#)|  Rev |
+-------------------------------------------------------------------------------+
| 0/2/0      |   8| 1| UP  |npu | UP  | UP  |NRML        |PON   |  1|  0|0x0000|
| 0/2/1      |   9| 1| UP  |npu | UP  | UP  |NRML        |PON   |  1|  0|0x0000|
| 0/2/2      |  10| 1| UP  |npu | UP  | UP  |NRML        |PON   |  1|  0|0x0000|
+-------------------------------------------------------------------------------+

SI Info :
+-------------------------------------------------------------------------------------------+
|   Card  | Board      | SI Board | SI Param | Retimer SI    | Retimer SI    | Front Panel
   |
|         | HW Version | Version  | Version  | Board Version | Param Version | PHY
   |
+-------------------------------------------------------------------------------------------+
|  LC2    |  0.41      |     1    |     9    |       NA      |       NA      |  DEFAULT
   |
+-------------------------------------------------------------------------------------------+
```

Dynamic Power Management

Table 16: Feature History Table

Feature Name	Release Information	Description
Dynamic Power Management	Release 7.3.15	The Dynamic Power Management feature considers certain dynamic factors before allocating power to the fabric and line cards. This feature has the following benefits: • Reduces number of PSUs required by accurately representing the maximum power consumption • Improves PSU efficiency by providing more accurate power allocation This feature thus optimizes power allocation and avoids overprovisioning power to a router.
Dynamic Power Management	Release 7.3.2	Previously available for fabric and line cards, this feature that helps avoid excess power allocation by considering dynamic factors before allocating power to them is now available for optical modules. To view the power allocation on a per port basis, a new command "**show environment power allocated [details]**" is introduced.
Dynamic Power Management	Release 7.3.3	The Dynamic Power Management feature is now supported on the following Cisco 8100 and 8200 series routers: • Cisco 8201 • Cisco 8202 • Cisco 8201-32-FH • Cisco 8101-32-FH
Dynamic Power Management	Release 7.5.2	The Cisco 8202-32FH-M router will now consider dynamic factors, such as optical modules, NPU power profile, and MACsec mode to enable improved power allocation and utilization.

Prior to Cisco IOS XR Release 7.3.15, when Cisco 8000 series routers were powered on or reloaded, the power management feature reserved power to fabric cards and allocated maximum power to line cards. The

power management feature wouldn't consider dynamic factors, such as the type of fabric or line cards in the chassis, or whether a fabric or line card was present in a slot.

The Dynamic Power Management feature considers such dynamic factors before allocating power to the fabric and line cards.

This feature has the following benefits:

- Reduces number of PSUs required by accurately representing the maximum power consumption
- Improves PSU efficiency by providing more accurate power allocation

This feature thus optimizes power allocation and avoids overprovisioning power to a router.

This feature is supported on the following Cisco 8000 series routers:

- Cisco 8804, 8808, 8812, and 8818 routers
- Cisco 8201, 8202, 8201-32-FH, and 8202-32FH-M routers
- Cisco 8101-32-FH

By default, this feature is enabled on the router.

The Dynamic Power Management feature allocates the total power to a router and its fabric card or line card based on the following parameters:

- Number and type of fabric cards installed on the router
- Fabric cards operating modes (5FC or 8FC)
- Number and type of line cards installed on the router
- Combination of line card and fabric card types installed
- NPU power mode configured on a fabric card
- Number and type of optics installed (supported in Cisco IOS XR Software Release 7.3.2 and later)
- MACSec-enabled ports (supported from Cisco IOS XR Software Release 7.3.3 and later)

  For details, see *Dynamic Power Management for MACSec-Enabled Ports* section in the *Configuring MACSec* chapter in the *System Security Configuration Guide for Cisco 8000 Series Routers*.

On 8202-32FH-M router, the Dynamic Power Management feature allocates the total power to a router based on the following parameters:

- Optical modules installed.
- NPU power profile. To identify the mode on which the router is operating, use the `hw-module npu-power-profile` command.
- MACSec mode. By default, MACSec mode is disabled on 8202-32FH-M router.

Note We recommend you work with your Cisco account representatives to calculate power requirements for the Cisco 8000 series router.

Power Allocation to Empty Card Slot

This feature allocates a minimum required power for all empty LC or FC slots. This minimum power is required to boot the CPU and FPGAs immediately when a card is inserted. The feature doesn't control booting up the CPU and FPGAs. Also, the minimum power is required to detect the card type before the feature decides if there's enough power to power up the data path.

For example, the following **show environment power** command output displays various LC or FC card statuses, and also shows allocated and used power.

Note The allocated power capacity shown in the following **show** command output isn't standard capacity. The allocated power capacity varies depending on various other factors.

```
Router# show environment power
Thu Apr 22 12:03:06.754 UTC
===============================================================================
CHASSIS LEVEL POWER INFO: 0
===============================================================================
   Total output power capacity (N + 1)             :    9600W +     6300W
   Total output power required                     :    9241W
   Total power input                               :    6146W
   Total power output                              :    5826W

===============================================================================
   Power       Supply         -------Input--------   -----Output---     Status
   Module      Type            Volts A/B   Amps A/B   Volts     Amps
===============================================================================
   0/PT0-PM0   PSU6.3KW-HV     245.5/245.7 5.1/5.0    54.7      43.1     OK
   0/PT0-PM1   PSU6.3KW-HV     0.0/245.2   0.0/7.4    54.3      31.7     OK
   0/PT0-PM2   PSU6.3KW-HV     0.0/246.9   0.0/7.5    54.1      32.3     OK

Total of Power Modules:       6146W/25.0A              5826W/107.1A

===============================================================================
   Location     Card Type               Power       Power        Status
                                        Allocated   Used
                                        Watts       Watts
===============================================================================
   0/RP0/CPU0   8800-RP                 95          69           ON
   0/RP1/CPU0   -                       95          -            RESERVED
   0/0/CPU0     88-LC0-36FH             796         430          ON
   0/1/CPU0     -                       102         -            RESERVED
   0/2/CPU0     88-LC0-36FH             796         430          ON
   0/3/CPU0     -                       102         -            RESERVED
   0/4/CPU0     -                       102         -            RESERVED
   0/5/CPU0     -                       102         -            RESERVED
   0/6/CPU0     -                       102         -            RESERVED
   0/7/CPU0     -                       102         -            RESERVED
   0/8/CPU0     -                       102         -            RESERVED
   0/9/CPU0     88-LC0-36FH             102         -            OFF
   0/10/CPU0    -                       102         -            RESERVED
   0/11/CPU0    -                       102         -            RESERVED
   0/FC0        -                       26          -            RESERVED
   0/FC1        -                       26          -            RESERVED
   0/FC2        -                       26          -            RESERVED
   0/FC3        8812-FC                 784         509          ON
   0/FC4        8812-FC                 784         503          ON
   0/FC5        8812-FC                 26          -            OFF
   0/FC6        8812-FC                 26          -            OFF
   0/FC7        8812-FC                 26          -            OFF
```

```
0/FT0        8812-FAN              1072        1000         ON
0/FT1        8812-FAN              1072        1012         ON
0/FT2        8812-FAN              1072        861          ON
0/FT3        8812-FAN              1072        1033         ON
```

This table describes the card slot statuses:

Table 17: Router Card Slot Status

Status	Description
RESERVED	When a slot is empty
OFF	When a card is inserted in a slot but power isn't allocated to the card
ON	When a card is allocated power and the card is in operational state

Low-Power Condition

When you insert an LC or FC in a card slot at the time when the router doesn't have enough power available to allocate to the new card, the dynamic power management feature doesn't provision power to the card. It raises the *ev_power_budget_not_ok* alarm, and gracefully shuts down the card.

In the following **show** command output, an FC inserted in the card slot location 0/FC6 is gracefully shut down due to lack of power:

```
Router# show shelfmgr history events location 0/FC6
Thu Apr 22 12:03:11.763 UTC
NODE NAME     : 0/FC6
CURRENT STATE : CARD_SHUT_POWERED_OFF
TIME STAMP    : Apr 20 2021 16:49:52
--------------------------------------------------------------------------------
DATE        TIME (UTC)  EVENT                    STATE
--------------------------------------------------------------------------------
Apr 20 2021 16:49:52    ev_powered_off           CARD_SHUT_POWERED_OFF
Apr 20 2021 16:49:52    ev_device_offline        STATE_NOT_CHANGED
Apr 20 2021 16:49:52    ev_unmapped_event        STATE_NOT_CHANGED
Apr 20 2021 16:49:48    transient_condition      CARD_SHUTDOWN
Apr 20 2021 16:49:48    ev_check_card_down_reaso CHECKING_DOWN_REASON
Apr 20 2021 16:49:48    ev_timer_expiry          CARD_SHUTDOWN_IN_PROGRESS
Apr 20 2021 16:48:46    ev_power_budget_not_ok   CARD_SHUTDOWN_IN_PROGRESS
Apr 20 2021 16:48:45    transient_condition      POWER_BUDGET_CHECK
Apr 20 2021 16:48:45    ev_fpd_upgrade_not_reqd  CARD_STATUS_CHECK_COMPLETE
Apr 20 2021 16:47:45    ev_card_status_check     CARD_STATUS_CHECK
Apr 20 2021 16:47:45    ev_card_info_rcvd        CARD_INFO_RCVD
Apr 20 2021 16:47:44    ev_device_online         DEVICE_ONLINE
Apr 20 2021 16:47:43    ev_timer_expiry          CARD_POWERED_ON
Apr 20 2021 16:47:33    ev_powered_on            CARD_POWERED_ON
Apr 20 2021 16:47:33    init                     CARD_DISCOVERED
--------------------------------------------------------------------------------
```

However, after an LC, FC, or chassis reload, the dynamic power management feature can't ensure that the same LCs, FCs, optics, or interfaces, which were operational earlier (before the reload), would become active again.

Note During a low-power condition, this feature doesn't borrow power from a redundant power supply.

Power Allocation to Optics

From Cisco IOS XR Release 7.3.2 onwards, power requirement for optics is also considered before allocating power to them.

To identify the power allocated for a particular interface, use the **show environment power allocated** [**details**] **location** *location* command.

When the optical modules are inserted, power is automatically allocated for that interface. If power has been allocated to the interface, then use the "**no shut**" command to enable the interface.

```
Router# show environment power allocated location 0/3/CPU0
Thu Oct  7 22:27:35.732 UTC
================================================================================
   Location    Components               Power
                                        Allocated
                                        Watts
================================================================================
  0/3/CPU0     Data-path                772
               OPTICS                   138
================================================================================
               Total                    910

Router# show environment power allocated details location 0/3/CPU0
Thu Oct  7 22:27:42.221 UTC
================================================================================
   Location    Components               Power
                                        Allocated
                                        Watts
================================================================================
  0/3/CPU0     Data-path                772
               0/3/0/0                  3
               0/3/0/1                  3
               0/3/0/2                  3
               0/3/0/3                  3
               0/3/0/4                  3
               0/3/0/5                  3
               0/3/0/6                  3
               0/3/0/7                  3
               0/3/0/8                  3
               0/3/0/9                  3
               0/3/0/10                 3
               0/3/0/11                 3
               0/3/0/12                 3
               0/3/0/13                 3
               0/3/0/14                 3
               0/3/0/15                 3
               0/3/0/16                 3
               0/3/0/17                 3
               0/3/0/18                 3
               0/3/0/19                 3
               0/3/0/20                 3
               0/3/0/21                 3
               0/3/0/22                 3
               0/3/0/23                 3
               0/3/0/24                 3
```

```
                0/3/0/25                3
                0/3/0/26                3
                0/3/0/27                3
                0/3/0/28                3
                0/3/0/29                3
                0/3/0/30                3
                0/3/0/31                3
                0/3/0/32                3
                0/3/0/33                3
                0/3/0/34                3
                0/3/0/35                3
                0/3/0/36                3
                0/3/0/37                3
                0/3/0/38                3
                0/3/0/39                3
                0/3/0/40                3
                0/3/0/41                3
                0/3/0/42                3
                0/3/0/43                3
                0/3/0/44                3
                0/3/0/46                3
==============================================================================
                Total                   910
```

When the power is not allocated to the interface, the following syslog error and alarms are displayed

```
!<--Syslog Error-->!
#LC/0/3/CPU0:Oct  7 22:46:48.114 UTC: optics_driver[165]: %PKT_INFRA-FM-3-FAULT_MAJOR :
ALARM_MAJOR :POWER ALLOCATION FAIL :DECLARE :0/3/CPU0:  Optics0/3/0/44
LC/0/3/CPU0:Oct  7 22:46:48.114 UTC: optics_driver[165]:
%L2-OPTICS-2-QSFP_POWER_ALLOCATION_FAILURE : Not enough power available to enable Optics
0/3/0/44

!<--Alarm-->!
Router#show alarms brief system active
Thu Oct  7 22:47:19.569 UTC

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



------------------------------------------------------------------------------------------
0/3/CPU0        Major        Software         10/07/2021 22:46:48 UTC     Optics0/3/0/44 -
 hw_optics:  Lack of available power to enable the optical module


0/3/CPU0        Major        Software         10/07/2021 22:47:06 UTC     Optics0/3/0/46 -
 hw_optics:  Lack of available power to enable the optical module
```

If power is not allocated to an interface and you attempt to enable that interface using the "**no shut**" command, the following syslog error is displayed:

```
LC/0/2/CPU0:Aug 30 18:01:14.930 UTC: eth_intf_ea[262]: %PLATFORM-VEEA-1-PORT_NOT_ENABLED :
 Power not allocated to enable the interface HundredGigE0_2_0_6.
```

Power Allocation to Fixed-Port Routers

The following **show environment power** command output displays power information for fixed-port routers and components.

```
Router# show environment power
Wed Feb 16 21:05:10.001 UTC
===============================================================================
CHASSIS LEVEL POWER INFO: 0
===============================================================================
   Total output power capacity (Group 0 + Group 1) :    1400W +     1400W
   Total output power required                     :    1033W
   Total power input                               :     390W
   Total power output                              :     255W

Power Group 0:
===============================================================================
   Power       Supply         ------Input----   ------Output---     Status
   Module      Type            Volts     Amps    Volts     Amps
===============================================================================
   0/PM0       PSU1.4KW-ACPE   244.5     0.8     12.0      11.1     OK

Total of Group 0:              195W/0.8A         133W/11.1A

Power Group 1:
===============================================================================
   Power       Supply         ------Input----   ------Output---     Status
   Module      Type            Volts     Amps    Volts     Amps
===============================================================================
   0/PM1       PSU1.4KW-ACPE   244.2     0.8     12.0      10.2     OK

Total of Group 1:              195W/0.8A         122W/10.2A

===============================================================================
   Location     Card Type               Power       Power        Status
                                        Allocated   Used
                                        Watts       Watts
===============================================================================
   0/RP0/CPU0   8201                    893         -            ON
   0/FT0        FAN-1RU-PE              28          -            ON
   0/FT1        FAN-1RU-PE              28          -            ON
   0/FT2        FAN-1RU-PE              28          -            ON
   0/FT3        FAN-1RU-PE              28          -            ON
   0/FT4        FAN-1RU-PE              28          -            ON
```

To identify the power allocated for a particular interface, use the **show environment power allocated** [**details**] **location** *location* command.

```
Router# show environment power allocated location 0/RP0/CPU0
Wed Feb 16 21:05:21.360 UTC
===============================================================================
   Location    Components              Power
                                       Allocated
                                       Watts
===============================================================================
  0/RP0/CPU0   Data-path               858
               OPTICS                  35
===============================================================================
               Total                   893


Router# show environment power allocated details location 0/RP0/CPU0
Wed Feb 16 21:05:36.142 UTC
===============================================================================
   Location    Components              Power
                                       Allocated
                                       Watts
===============================================================================
  0/RP0/CPU0   Data-path               858
```

```
                0/0/0/19                21
                0/0/0/18                14
================================================================================
                Total                   893
```

Disabling Dynamic Power Management

By default, the dynamic power management is enabled on a router. The following example shows how to disable dynamic power management:

```
RP/0/RP0/CPU0:ios(config)#power-mgmt action disable
RP/0/RP0/CPU0:ios(config)#commit
```

Caution After disabling the dynamic power management feature, you must manage the router power on your own. So, use this command with caution.

Note To reenable dynamic power management, use the **no power-mgmt action disable** command.

On-demand transfer of Redundant Power Modules to Power Reservation Pool

Table 18: Feature History Table

Feature Name	Release Information	Feature Description
On-demand transfer of Redundant Power Modules to Power Reservation Pool	Release 7.11.1	The Cisco 8800 Series Modular Routers now have a functionality that allows them to transfer their redundant Power Supply Units (PSUs) to the power reservation pool when there is inadequate power supply. This capability helps prevent the router from shutting down hardware components due to a lack of power in the reservation pool, which used to occur due to the router prioritizing redundancy over power availability in the power reservation pool. Consequently, the router now raises an alarm indicating redundancy loss when it transfers PSUs to the power reservation pool. This feature ensures that the router components reserve the necessary power, even when redundancy is enabled.

The Cisco 8000 Series Modular Routers offer redundancy while managing Power Supply Units (PSUs), providing continuous operation if there is PSU failure. By default, the router operates in N+1 redundancy, where N represents the number of PSUs allotted to the power reservation pool for powering the router components, and 1 indicates the backup PSU. You can use the **power-mgmt redundancy-num-pms** *number* command in XR Config mode mode to configure the PSU redundancy from N+1 to N+x, where x is the number of redundant PSUs required. The total number of functioning PSUs must be at least x more than the number of PSUs required to support the power demanded by all the components in the system for optimal router functionality. The range of values assigned to x is 0–11, where 0 implies no power redundancy. The router uses the redundant PSUs only when there is a PSU failure. But, if the power requirement of the router increases than the available power offered by PSUs, the router prioritizes maintaining PSU redundancy overpowering the components.

Starting from Cisco IOS XR Release 7.11.1, the Cisco 8800 Modular Routers prioritize powering the router components over preserving redundancy. The router transfers the redundant PSUs to a power reservation pool to power the router components on demand. The router utilizes the redundant PSUs to increase the power capacity in the power reservation pool rather than maintaining redundancy. For example, consider a scenario with 18900W (3 6300W PSUs) available power. Initially, the router reserves 12600W (using 2 PSUs) in the power reservation pool and retains 6300W (one PSU) as a backup to maintain N+1 redundancy. Suppose the router needs to reserve power for any components to power up and needs more power than is available in the reservation pool. In that case, the router uses the entire 18900W with all three PSUs to power the components by transferring the redundant PSU to the power reservation pool. The router then triggers a redundancy loss alarm with such an assignment. However, if any further actions result in reduced power consumption in the router, the system automatically restores redundancy and clears the redundancy lost alarm.

On redundancy loss, the router raises a **Critical** severity **Power Module redundancy lost** alarm. You can use the **show alarms brief** command to view the redundancy lost alarm.

Syslog messages for transforming redundant PSU into borrowable resource:

Syslog message created while redundancy loss (transforming redundant PSU to functional PSU):

```
RP/0/RP0/CPU0:Jul 24 11:49:01.316 UTC: envmon[214]: %PKT_INFRA-FM-3-FAULT_MAJOR : ALARM_MAJOR
 :Power Module redundancy lost :DECLARE :0:
```

Syslog message created while restoring redundancy:

```
RP/0/RP0/CPU0:Jul 24 11:49:11.375 UTC: envmon[214]: %PKT_INFRA-FM-3-FAULT_MAJOR : ALARM_MAJOR
 :Power Module redundancy lost :CLEAR :0:
```

You can also use the **show environment** view the redundancy status of the PSUs in the router.

The following section details the commands to verify the redundancy status in the router:

Router with N+1 redundancy:

```
Router:ios# show environment power
          ================================================================================

            CHASSIS LEVEL POWER INFO: 0
          ================================================================================

            Total output power capacity (N + 1)             :   12600W +     6300W
            Total output power required                     :   11545W
            Total power input                               :    3302W
            Total power output                              :    3004W

          ================================================================================

            Power       Supply         -------Input--------   -----Output---     Status
            Module      Type            Volts A/B   Amps A/B   Volts     Amps
          ================================================================================
```

```
  0/PT5-PM0   PSU6.3KW-HV     240.5/241.3 2.2/2.4    55.1      18.3     OK
  0/PT5-PM1   PSU6.3KW-HV     240.5/240.8 2.1/2.3    54.8      17.3     OK
  0/PT5-PM2   PSU6.3KW-HV     242.2/241.1 2.3/2.4    54.9      19.1     OK

  Total of Power Modules:       3302W/13.7A              3004W/54.7A

==============================================================================

  Location     Card Type              Power       Power        Status
  Allocated   Used
  Watts       Watts
==============================================================================

  0/RP0/CPU0   8800-RP                105         78           ON
  0/RP1/CPU0   -                      105         -            RESERVED
  0/0/CPU0     8800-LC-36FH           1097        513          ON
  0/1/CPU0     -                      102         -            RESERVED
  0/2/CPU0     88-LC0-36FH            102         0            OFF
  0/3/CPU0     -                      102         -            RESERVED
  0/4/CPU0     -                      102         -            RESERVED
  0/5/CPU0     -                      102         -            RESERVED
  0/6/CPU0     -                      102         -            RESERVED
  0/7/CPU0     -                      102         -            RESERVED
  0/8/CPU0     -                      102         -            RESERVED
  0/9/CPU0     -                      102         -            RESERVED
  0/10/CPU0    -                      102         -            RESERVED
  0/11/CPU0    -                      102         -            RESERVED
  0/12/CPU0    -                      102         -            RESERVED
  0/13/CPU0    -                      102         -            RESERVED
  0/14/CPU0    -                      102         -            RESERVED
  0/15/CPU0    -                      102         -            RESERVED
  0/16/CPU0    -                      102         -            RESERVED
  0/17/CPU0    -                      102         -            RESERVED
  0/FC0        -                      32          -            RESERVED
  0/FC1        -                      32          -            RESERVED
  0/FC2        8818-FC0               584         475          ON
  0/FC3        -                      32          -            RESERVED
  0/FC4        8818-FC0               584         472          ON
  0/FC5        -                      32          -            RESERVED
  0/FC6        -                      32          -            RESERVED
  0/FC7        -                      32          -            RESERVED
  0/FT0        8818-FAN               1786        237          ON
  0/FT1        8818-FAN               1786        228          ON
  0/FT2        8818-FAN               1786        234          ON
  0/FT3        8818-FAN               1786        228          ON
```

Router with redundancy loss:

```
Router:ios# sh env power
==============================================================================

  CHASSIS LEVEL POWER INFO: 0
==============================================================================

  Total output power capacity (N + 1)             :   18900W +        0W
  Total output power required                     :   12689W
  Total power input                               :    3302W
  Total power output                              :    3004W

==============================================================================

  Power       Supply         -------Input--------   -----Output---     Status
  Module      Type            Volts A/B   Amps A/B   Volts     Amps
==============================================================================
```

```
  0/PT5-PM0   PSU6.3KW-HV     240.5/241.3 2.2/2.4    55.1      18.3     OK
  0/PT5-PM1   PSU6.3KW-HV     240.5/240.8 2.1/2.3    54.8      17.3     OK
  0/PT5-PM2   PSU6.3KW-HV     242.2/241.1 2.3/2.4    54.9      19.1     OK

  Total of Power Modules:       3302W/13.7A              3004W/54.7A

==============================================================================

  Location     Card Type              Power       Power        Status
  Allocated   Used
  Watts       Watts
==============================================================================

  0/RP0/CPU0   8800-RP                105         78           ON
  0/RP1/CPU0   -                      105         -            RESERVED
  0/0/CPU0     8800-LC-36FH           1097        513          ON
  0/1/CPU0     -                      102         -            RESERVED
  0/2/CPU0     88-LC0-36FH            916         510          ON
  0/3/CPU0     -                      102         -            RESERVED
  0/4/CPU0     -                      102         -            RESERVED
  0/5/CPU0     -                      102         -            RESERVED
  0/6/CPU0     -                      102         -            RESERVED
  0/7/CPU0     -                      102         -            RESERVED
  0/8/CPU0     -                      102         -            RESERVED
  0/9/CPU0     -                      102         -            RESERVED
  0/10/CPU0    -                      102         -            RESERVED
  0/11/CPU0    -                      102         -            RESERVED
  0/12/CPU0    -                      102         -            RESERVED
  0/13/CPU0    -                      102         -            RESERVED
  0/14/CPU0    -                      102         -            RESERVED
  0/15/CPU0    -                      102         -            RESERVED
  0/16/CPU0    -                      102         -            RESERVED
  0/17/CPU0    -                      102         -            RESERVED
  0/FC0        -                      32          -            RESERVED
  0/FC1        -                      32          -            RESERVED
  0/FC2        8818-FC0               749         475          ON
  0/FC3        -                      32          -            RESERVED
  0/FC4        8818-FC0               749         472          ON
  0/FC5        -                      32          -            RESERVED
  0/FC6        -                      32          -            RESERVED
  0/FC7        -                      32          -            RESERVED
  0/FT0        8818-FAN               1786        237          ON
  0/FT1        8818-FAN               1786        225          ON
  0/FT2        8818-FAN               1786        234          ON
  0/FT3        8818-FAN               1786        228          ON
Router:ios# sh alarms brief system active

------------------------------------------------------------------------------
            Active Alarms

------------------------------------------------------------------------------
            Location        Severity     Group           Set Time
Description



------------------------------------------------------------------------------
            0/RP0/CPU0      Critical     Software        10/27/2023 00:22:08 UTC
Redundancy Partner Not Present


            0               Major        Environ         10/27/2023 00:23:48 UTC    Power
 Module redundancy lost
```

```
           0/RP0/CPU0      Minor        Fabric          10/27/2023 00:22:39 UTC    Fabric
Plane-0 status

           0/RP0/CPU0      Minor        Fabric          10/27/2023 00:22:39 UTC    Fabric
Plane-1 status

           0/RP0/CPU0      Minor        Fabric          10/27/2023 00:22:39 UTC    Fabric
Plane-3 status

           0/RP0/CPU0      Minor        Fabric          10/27/2023 00:22:39 UTC    Fabric
Plane-5 status

           0/RP0/CPU0      Minor        Fabric          10/27/2023 00:22:39 UTC    Fabric
Plane-6 status

           0/RP0/CPU0      Minor        Fabric          10/27/2023 00:22:39 UTC    Fabric
Plane-7 status

           0/RP0/CPU0      Major        Software        10/27/2023 00:22:59 UTC
Communications Failure With Cisco Licensing Cloud

           0               Major        Environ         10/27/2023 00:23:48 UTC    Power
Module redundancy lost
```

Power Redundancy Protection

Table 19: Feature History Table

Feature Name	Release Information	Feature Description
Power Redundancy Protection	Release 24.1.1	You can now prevent power module exhaustion or failure due to power redundancy issues in the power feeds with the help of alarms that warn that the total output power required by the router exceeds the total feed redundancy capacity. You can configure either single-fault protection or dual fault protection, depending on whether you want to trigger alarms during redundancy failures in the power supply feed, PSU redundancy, or both. The feature introduces these changes: **CLI:** • **power-mgmt feed-redundancy** • The `Total feed redundancy capacity` field is added to the **show environment** command.

The Cisco 8000 Series Modular Routers have two redundancy mechanisms to ensure the router continues functioning even during power supply failures:

- The PSU redundancy involves having extra power supplies that can take over if one fails, ensuring continuous operation.
- The power feed redundancy divides the input power into A and B feeds. When both feeds are functioning normally, they share the power load equally. However, if one of the feeds fails, the other feed scales up to its maximum capacity or the power supply unit (PSU) will operate with reduced input to ensure that the power supply to the router is uninterrupted.

These power redundancy options provide a high level of reliability and minimize the risk of network downtime due to power supply failures.

The routers now have power redundancy protection that triggers alarms for PSU and feed redundancy failures when the total output power required by the router exceeds its total feed redundancy capacity. You can configure the total feed redundancy capacity in two modes- single fault protection and dual fault protection.

The **single fault protection** mode monitors the router against a **power supply feed or PSU** redundancy failure. Meanwhile, the **dual fault protection** monitors the router against a **power supply feed and PSU** redundancy failure simultaneously. You can also customize the PSU single feed capacity in the router. Each

PSU has a default power range for the single feed; you can configure a value within the range to meet your specific infrastructure requirements.

The feed redundancy alarm is triggered when the total output power required exceeds the total feed redundancy capacity. The router's total feed capacity is determined by the least of two factors: feed redundancy capacity and PSU redundancy capacity. The PSU redundancy capacity is the number of power supply units minus the redundant ones (N) multiplied by a dual feed capacity. On the other hand, the feed redundancy capacity is the total number of PSUs multiplied by a single feed capacity. In single-fault protection, the PSU refers to the router's total number of power supply units (N+1). In dual-fault protection, the PSU refers to the number of power supply units minus the redundant ones (N).

For example, consider a router that has a total of 9 PSUs with a default N + 1 power redundancy configuration. The PSU feed capacity with dual feed is 4800 W and the single feed capacity value is set 3200 W, then the total feed redundancy capacity would be:

Power Redundancy Protection	Total Number of PSUs	PSU redundancy	Number of PSUs minus the redundant ones (N)	Dual Feed Capacity	Single Feed Capacity	Feed Redundancy Capacity	PSU Redundancy Capacity	Total Feed Redundancy Capacity
Single fault protection	9	N+1	8	4800 W	3200 W	28800 W	38400 W	28800 W
Dual fault protection	9	N+1	8	4800 W	3200 W	25600 W	38400 W	25600 W

Guidelines and Restrictions for Power Redundancy Protection

- By default, the router doesn’t enable Power Redundancy Protection.
- The Power Redundancy Protection feature doesn’t impact the power budgeting in the routers.
- For maximum power redundancy protection, use the dual fault protection.
- For total feed redundancy capacity calculations, the router considers only the PSUs with A and B inputs. Both A and B inputs must be within the operating range in healthy conditions. If either feed is unavailable, the router excludes such PSUs from the calculations.
- The router considers all PSUs, including redundant PSUs with two feeds (within the operating range in healthy condition) for feed redundancy capacity in single fault protection. However, the router excludes the redundant PSUs for feed redundancy capacity in dual fault protection. If the router has 8 PSUs and N+3 redundancy, single fault protection calculation considers all eight PSUs, whereas dual fault protection considers just 5 PSUs.

Configure Power Redundancy Protection

To configure the power redundancy protection mode and PSU single feed capacity, you can use the **power-mgmt feed-redundancy** command.

Single fault protection with PSU single feed capacity set to 2400 Watts

Configuration:

```
Router# config
Router(config)# power-mgmt feed-redundancy single-fault-protection capacity 2400
Router(config)# commit
```

Running Configuration:

```
Router# show run power
…
power-mgmt feed-redundancy single-fault-protection capacity 2400
…
```

Verification:

```
Router# show env power
================================================================================
CHASSIS LEVEL POWER INFO: 0
================================================================================
   Total output power capacity (N + 1)             :   28800W +     4800W
   Total output power required                     :    6679W >>>>> 1
   Total power input                               :    2394W
   Total power output                              :    2066W
   Total feed redundancy capacity (Single Fault)   :   16800W >>>>> 2
   //*The router triggers feed redundancy loss alarm when 1 > 2.**//
================================================================================
   Power       Supply         -------Input--------   -----Output---     Status
   Module      Type            Volts A/B   Amps A/B   Volts     Amps
================================================================================
   0/PT0-PM0   PSU4.8KW-DC100  62.8/62.7   2.6/2.5    55.2      5.3      OK
   0/PT0-PM1   PSU4.8KW-DC100  62.7/62.7   2.7/2.6    55.3      5.3      OK
   0/PT0-PM3   PSU4.8KW-DC100  61.0/62.7   2.6/2.5    55.2      4.8      OK
   0/PT1-PM0   PSU4.8KW-DC100  67.3/67.3   2.7/2.5    55.3      5.2      OK
   0/PT1-PM1   PSU4.8KW-DC100  67.3/67.2   2.8/2.7    55.3      5.7      OK
   0/PT1-PM2   PSU4.8KW-DC100  67.3/67.4   2.7/2.7    55.2      5.6      OK
   0/PT1-PM3   PSU4.8KW-DC100  67.3/67.3   2.6/2.5    55.3      5.5      OK

Total of Power Modules:       2394W/36.7A              2066W/37.4A
```

Dual fault protection with PSU single feed capacity set to 2400 Watts

Configuration:

```
Router# config
Router(config)# power-mgmt feed-redundancy dual-fault-protection capacity 2400
Router(config)# commit
```

Running Configuration:

```
Router# show run power
…
power-mgmt feed-redundancy dual-fault-protection capacity 2400
…
```

Verification:

```
Router# show env power
================================================================================
CHASSIS LEVEL POWER INFO: 0
================================================================================
   Total output power capacity (N + 1)             :   28800W +     4800W
   Total output power required                     :    6679W >>>>> 1
   Total power input                               :    2394W
   Total power output                              :    2066W
   Total feed redundancy capacity (Dual Fault)     :   14400W >>>>> 2
 //*The router triggers feed redundancy loss alarm when 1 > 2.**//
================================================================================
```

```
   Power       Supply         -------Input--------   -----Output---     Status
   Module      Type            Volts A/B   Amps A/B   Volts     Amps
==============================================================================
   0/PT0-PM0   PSU4.8KW-DC100  62.8/62.7   2.6/2.5    55.2      5.3      OK
   0/PT0-PM1   PSU4.8KW-DC100  62.7/62.7   2.7/2.6    55.3      5.3      OK
   0/PT0-PM3   PSU4.8KW-DC100  61.0/62.7   2.6/2.5    55.2      4.8      OK
   0/PT1-PM0   PSU4.8KW-DC100  67.3/67.3   2.7/2.5    55.3      5.2      OK
   0/PT1-PM1   PSU4.8KW-DC100  67.3/67.2   2.8/2.7    55.3      5.7      OK
   0/PT1-PM2   PSU4.8KW-DC100  67.3/67.4   2.7/2.7    55.2      5.6      OK
   0/PT1-PM3   PSU4.8KW-DC100  67.3/67.3   2.6/2.5    55.3      5.5      OK

Total of Power Modules:       2394W/36.7A              2066W/37.4A
```

Alarms for power redundancy loss

You can use the **show alarms brief** command to view the power redundancy alarm:

Note The router triggers the `Power Module redundancy feed mode lost` alarm only when **Total output power required** exceeds **Total feed redundancy capacity**.

```
Router# show alarms brief system active
------------------------------------------------------------------------------------------------------------------
Active Alarms
------------------------------------------------------------------------------------------------------------------
Location        Severity     Group           Set Time                    Description


------------------------------------------------------------------------------------------------------------------


0              Major        Environ        11/27/2023 12:55:08 UTC    Power Module redundancy
 feed mode lost
```

System Log messages for power redundancy loss

Syslog message created while power redundancy loss (total output power exceeds total feed redundancy capacity):

```
RP/0/RP0/CPU0:Dec 15 10:24:29.489 UTC: envmon [123]: %PKT_INFRA-FM-3-FAULT_MAJOR : ALARM_MAJOR
 :Power Feed redundancy lost :DECLARE :0
```

Ability to Set Maximum Power Limit for the Router

Table 20: Feature History Table

Feature Name	Release Information	Feature Description
Ability to Set Maximum Power Limit for the Router	Release 7.11.1	We are introducing functionality to set the maximum power limit for a router to improve power management and distribution in the PSUs. It prevents a router from using more than the configured power and also gives the ability to limit the reservation pool regardless of how many power supplies are present. In the previous releases, the ability to prevent a router from using more than a configured amount of power was unavailable. This feature introduces the following change: **CLI** • **power-mgmt configured-power-capacity**

In the earlier releases, there was no mechanism to limit the power a router consumed. Routers could draw more than the infrastructure could handle. Over power consumption could result in system brownout.

With the Cisco IOS XR Software Release 7.11.1, you can allocate system power based on max power capacity configuration. This prevents the router from allocating more power than the infrastructure can handle. It also gives you the ability to limit power to a router according to your infrastructure requirements. The max power capacity parameter doesn't allow power consumed by the hardware to cross the configured amount.

The criteria to set maximum power limit is that the value must be set between the current allocated power and the available maximum power at time of configuration.

This feature is not applicable for fixed routers.

A new command **power-mgmt configured-power-capacity** has been introduced with this feature.

A new alarm **PKT_INFRA-FM-3-FAULT_MAJOR : ALARM_MAJOR :Power reservation exceeds configured power** is introduced to be raised when the max power capacity is crossed.

Note This alarm is extremely rare and is raised only when the power reservation exceeds configured power. This can only happen when hardware is inserted, it is granted power without a request, such as a fan tray.

Upgrading FPD for PSU

Table 21: Feature History Table

Feature Name	Release Information	Feature Description
Optimized PSU FPD Upgrade	Release 7.8.1	We have optimized the upgrade process of Field-Programmable Devices (FPDs) associated with the Power Supply Unit (PSUs) on the router. During the installation and PSU insertion process on the router, the FPDs associated with the PSUs are automatically upgraded. Starting this release, the PSU FPDs are grouped in the form of a parent FPD and its related child FPDs, and the upgrade image is downloaded only once. The upgrade is then triggered on the parent FPD PSU and replicated to the child FPD PSUs. In earlier releases, you downloaded the FPD image for each FPD associated with that PSU, and the upgrade process was then triggered sequentially. This process was time-consuming. The feature is supported on the following PSUs: • PSU2KW-ACPI • PSU2KW-HVPI • PSU3KW-HVPI • PSU4.8KW-DC100

From Cisco IOS XR Software Release 7.8.1, the PSU FPD upgrade is optimized. PSU FPDs are now grouped in the form of parent PSU FPD which are related to the child PSU FPDs. The software image is downloaded once for the parent FPD and replicated to the children FPDs in the same group. Prior to this release, for example, if a PSU with five FPDs that share the same image across the FPDs needed a software upgrade, there were five upgrades triggered serially. As it is the same image which used to get downloaded five times, one for each FPD. It was redundant and time consuming.

The parent and child FPDs contain the same group info. If upgrade is required on the parent or the child PSU FPD, the parent FPD is added to the upgrade queue and the upgrade is triggered through CLI. Once upgrade is completed, the parent and child FPD software versions are updated.

If you want to upgrade the software version for a FPD PSU which is not a parent, it gets blocked in CLI by the FPD server.

Note You must disable **auto FPD upgrade** for PSUs before upgrading the router to Cisco IOS XR Software Release 7.9.1 or later if your router uses any of the following PSUs:

- PSU2KW-ACPI
- PSU2KW-ACPE
- PSU2KW-HVPI
- PSU4.8KW-DC100

To disable auto FPD upgrade, use the following command:

fpd auto-upgrade exclude pm

```
RP/0/RSP0/CPU0:ios# show running-config fpd auto-upgrade
RP/0/RP0/CPU0:ios(config)#fpd auto-upgrade exclude pm
RP/0/RP0/CPU0:ios(config)#commit
RP/0/RP0/CPU0:ios#
```

Automatic FPD Upgrade for PSU

Feature Name	Release Information	Feature Description
Automatic FPD upgrade for PSU	Release 7.5.2	Automatic FPD upgrade for PSUs is now enabled. In earlier releases, automatic upgrades did not apply to FPDs associated with the PSUs.

During the installation and Power Supply Unit (PSU) insertion process, the Field-Programmable Devices (FPD) associated with the PSUs are automatically upgraded.

Note The PSUs are upgraded sequentially, hence the PSU FPD upgrades take longer. You can choose to exclude PSUs from the auto upgrade flow. This restricts the PSUs from being upgraded either upon insertion, or during system upgrade.

To exclude the PSU FPDs from auto upgrading, use the following CLI:

fpd auto-upgrade exclude pm

```
RP/0/RSP0/CPU0:router# show running-config fpd auto-upgrade
Wed Mar 30 20:52:55.079 UTC
fpd auto-upgrade enable
fpd auto-upgrade exclude pm
```

Note When you upgrade from an earlier unsupported version to a version that supports Automatic FPD upgrade for PSU, the PSU upgrade might happen on bootup.

Auto upgrade support for SC/MPA

In Spitfire-Centralized, the auto upgrade on bootup path is being supported for new CPU less cards SC and MPA.

The RP and SC cards together form a domain in Active and Standby nodes. The respective domain lead (RP) is responsible to trigger the auto upgrade of respective SC cards.

Configuring the Compatibility Mode for Q100 and Q200-based Line Cards

Table 22: Feature History Table

Feature Name	Release Information	Description
Configure Compatibility Mode for Q100 and Q200-based Line Cards	Release 7.7.1	You can now configure the compatibility behavior of line cards to operate in Q100 mode (default behavior) or in Q200 mode when you have a mix of Q100-based line cards and Q200-based line cards that are installed in a router. In earlier releases, in a mixed mode combination, where multiple generations of line cards were installed, the behavior was to make the second-generation line cards interoperate with the first-generation line cards. However, this led the NPUs to set lower resource limits for the newer generation line cards to ensure backward compatibility. Also, the router didn't fully utilize the improved scale, higher capacity, and feature-rich capabilities of the newer generation line cards. This compatibility feature now enables you to select if you want the line cards to operate in Q100 or Q200 mode. The **hw-module profile npu-compatibility** command is introduced for this feature.

In earlier releases, if you install a mix of Q100-based line cards and Q200-based line cards, the Q200-based line cards operate in a scaled-down (Q100) mode by default.

The compatibility feature now allows you to choose if you want line cards to operate in Q100 mode (default behavior) or in Q200 mode. In Q200 mode, the router boots only the Q200-based line cards and gracefully shuts down the Q100-based line cards.

For example, if a router has a Q100 ASIC family line card and you try to add a line card from the Q200 ASIC family, the Q200 ASIC line card operates in a scaled down mode to be able to work with the older generation-Q100 line cards. With the new implementation, you can choose if you want the router to work in the Q100 mode or shutdown the Q100-based linecards, and use the Q200 ASIC line cards in the Q200 mode.

FAQs About the New Implementation

- **Can the line cards still be used in scaled down mode, like in the previous scenario?**

  Yes, you can still switch to the previous implementation, if you may, to the scaled down mode.

- **What all ASICs can participate in the new implementation?**

  Q200 and Q100

- **Is there any default ASIC set by the system?**

  For a distributed chassis, the default ASIC is Q100.

- **Do I need to reboot the router after implementing a new ASIC line card?**

  Yes, reboot the router for the new ASIC line cards to take effect.

Usage Guidelines and Limitations

The following guidelines and limitations apply when you configure the line cards from different ASIC families:

- By default, a mix of Q100 and Q200 line cards results in the Q200 line cards operating in Q100 (scaled-down) mode. Configuring Q100 mode results in the same (default) behavior.
- To be able to use the Q200-based line cards to their full capacity, use the **hw-module profile npu-compatibility** command and set it to operate in the Q200 mode. Else, the Q200-based line cards scale down to the Q100 mode, which is the default behavior.
- Reboot the router for the compatibility mode to take effect. If the system detects a noncompatible line card, it shuts down that line card. For example, in Q200 mode, the router boots only the Q200-based line cards and gracefully shuts down the Q100-based line cards.
- The **hw-module profile npu-compatibility** command isn't configurable on the Cisco 8100 and 8200 Series fixed chassis.

This table lists the Q100 and Q200-based line cards that support the compatibility mode:

ASIC Family	Line Card
Q100-based line cards	8800-LC-48H
	8800-LC-36FH
Q200-based line cards	88-LC0-34H14FH
	88-LC0-36FH
	88-LC0-36FH-M

Line Card Behavior

The following table explains how the various line cards take precendence when installed from different ASIC families. The precedence followed by the system is: Q200 > Q100, where the newer generation line cards take precedence over an older generation line card.

ASIC Family of Installed Line Cards	Compatibility Mode Configured?	Compatibility Mode	Router Behavior during Bootup for the Line Cards
Q200 and Q100	N	Default (Q100)	Q200 line cards boot up and operate in Q100 mode, Q100 up.
	Y	Q200	Q200 line cards boot up, Q100 line cards shut down.
	Y	Q100	All line cards boot up, Q200 line cards operate in Q100 mode.
Q200 and Q200	N	Default (Q100)	Both the Q200 line cards boot up and operate in Q100 mode.
	Y	Q200	Both the Q200 line cards boot up

Configuring Line Cards from Different ASICs

To configure a router for handling line cards of different ASIC families, use the **hw-module profile npu-compatibility** command. To go back to the default mode, use the **no** form of this command.

The following are the options available in command and their descriptions:

npu-compatibility	Allows you to make a router compatible with an ASIC family.
mode-name	Allows you to set the mode, such as Q100 or Q200.

The following is a configuration example:

```
Router:ios(config)#hw-module profile npu-compatibility q200
Tue Dec 7 15:06:53.697 UTC
Chassis mode will be activated after a manual reload of chassis/all line cards
Router:ios(config)#commit
Tue Dec 7 15:06:54.646 UTC
LC/0/1/CPU0:Dec 7 15:06:54.796 UTC: npu_drvr292:
%FABRIC-NPU_DRVR-3-HW_MODULE_PROFILE_NPU_COMPATIBILITY_CHASSIS_CFG_CHANGED : Please reload
chassis for the configuration to take effect
end
Router:ios(config)#end
Router:ios#
```

Running Configuration

```
RP/0/RP0/CPU0:ios# show ver
```

```
Mon Jun 27 19:25:52.947 UTC
Cisco IOS XR Software, Version 7.7.1.27I LNT
Copyright (c) 2013-2022 by Cisco Systems, Inc.

Build Information:
 Built By     : ingunawa
 Built On     : Wed Jun 01 23:50:09 UTC 2022
 Build Host   : iox-ucs-060
 Workspace    : /auto/iox-ucs-060-san1/prod/7.7.1.27I.SIT_IMAGE/8000/ws
 Version      : 7.7.1.27I
 Label        : 7.7.1.27I

cisco 8000 (VXR)
cisco 8808 (VXR) processor with 32GB of memory
ios uptime is 3 minutes
Cisco 8808 8-slot Chassis

RP/0/RP0/CPU0:ios#

RP/0/RP0/CPU0:ios# conf
Mon Jun 27 19:24:40.621 UTC
RP/0/RP0/CPU0:ios(config)# hw-module profile npu-compatibility ?
  Q100  Use Q100 for Chassis mode
  Q200  Use Q200 for Chassis mode
```

Verification

```
RP/0/RP0/CPU0:ios# show hw-module profile npu-compatibility matrix
Mon Jun 27 19:41:47.560 UTC
Node              Card Type                NPU Type
-----------------------------------------------------
0/0/CPU0          8800-LC-48H              Q100

            Compatibility       Compatibility
NPU Type   Mode Q100            Mode Q200
-------------------------------------------------
Q100        Compatible          Not Compatible
Q200        Compatible          Compatible

Default mode: Q100
RP/0/RP0/CPU0:ios# show hw-module profile npu-compatibility
Mon Jun 27 19:41:59.318 UTC
-------------------------------------------------------------------
Knob                          Status          Applied   Action
-------------------------------------------------------------------
npu_compatibility             Unconfigured    N/A       None

RP/0/RP0/CPU0:ios#
```

Storage Media Sanitization

Table 23: Feature History Table

Feature Name	Release Information	Feature Description
Storage Media Sanitization	Release 7.5.1Release 7.3.4	To comply with NIST SP 800-88 guidelines for Media Sanitization, it is important that your organization ensures that no easily reconstructible data is stored in the router and associated devices after it has left the control of your organization or is no longer protected by confidentiality categorization. With this feature, you can erase and overwrite any sensitive data, configuration, or keys present in the route processor or line card, ensuring media sanitization and preventing unauthorized data retrieval.

When you identify an RP or line card for RMA, or you require to ship it outside your organization, a service personnel may not be available on-site to remove the card immediately. However, you can reset your RP or line card to erase customer-sensitive data and let the RP or line card remain in the slot. The RP or line card shuts down automatically after the factory reset is complete.

Guidelines

- We recommend using **factory-reset** without performing **commit replace** for securely removing the files in the misc/config folder.
- The RP or line card shuts down automatically if the factory reset takes more than 30 minutes, you can perform the factory reset again. The console displays the following log message during automatic shutdown:

```
[ TIME ] Timed out starting Power-Off.
[ !!  ] Forcibly powering off as result of failure.
```

- If your router has dual RPs, and to perform the factory reset on both the RPs, first reset the standby RP from the active RP. After the reset is complete, the standby RP automatically shuts down, you can then reset the active RP.

Prerequisites

The RP or line card must be operational to perform factory reset.

Commands

Use the **factory-reset** command for erasing the following folders of RP or line card:

- /misc/disk1
- /misc/scratch
- /var/log
- /misc/config

Run the following command through the console port of the router to erase customer-sensitive data in the RP or line card:

factory-reset location <*location-id*> - erases customer-sensitive data in the specified location

Note Factory-reset logs are displayed on the console port of the node where the reset is performed.

The following steps explain how to reset your RP or line card to factory settings:

1. Erasing the RP or line card folder contents: Run the **factory-reset location** command to delete the encryption keys and erase the customer-sensitive data from the RP or line card.

   The following example shows how to perform the factory-reset command on an RP:

```
Router#factory-reset location 0/RP1/CPU0
Factory reset requested
Started punching watchdog
Started cleaning up mount point: /misc/scratch
Started syncing folder: /misc/scratch
Finished syncing folder: /misc/scratch
Finished cleaning up mount point: /misc/scratch
factory_reset_stop.sh
++++++++++++++++++++++++++++++++++++++++++++++
Started cleaning up mount point: /var/log
Started syncing folder: /var/log
Finished syncing folder: /var/log
Finished cleaning up mount point: /var/log
factory_reset_stop.sh
++++++++++++++++++++++++++++++++++++++++++++++
Started cleaning up mount point: /misc/disk1
Started syncing folder: /misc/disk1
Finished syncing folder: /misc/disk1
Finished cleaning up mount point: /misc/disk1
factory_reset_stop.sh
++++++++++++++++++++++++++++++++++++++++++++++
Started cleaning up folder: /misc/config
UTC 2022 Started syncing folder: /misc/config
Finished syncing folder: /misc/config
Finished cleaning up folder: /misc/config
factory_reset_stop.sh
++++++++++++++++++++++++++++++++++++++++++++++
Started cleaning up folder: /var/xr/enc/misc/config
/var/xr/enc/misc/config not present
Finished cleaning up folder: /var/xr/enc/misc/config
factory_reset_stop.sh
++++++++++++++++++++++++++++++++++++++++++++++
Started cleaning up folder: /mnt/rootfs/misc/config
/mnt/rootfs/misc/config not present
```

```
Finished cleaning up folder: /mnt/rootfs/misc/config
factory_reset_stop.sh
++++++++++++++++++++++++++++++++++++++++++++
Encrypted logical volume does not exist. Nothing to remove.
/usr/local/etc/fpga-functions: line 797: 10912 Terminated
/usr/local/etc/punch-wd.sh
Stopped punching watchdog
```

2. Verifying factory reset: Use the **show shelfmgr history events location** command to verify the successful completion of the factory-reset in the standby RP or line card.

   The following example shows how to verify the factory-reset command:

```
RP/0/RP0/CPU0:Router#show shelfmgr history events location 0/RP1/CPU0
Tue Mar 15 01:45:56.402 UTC
NODE NAME     : 0/RP1/CPU0
CURRENT STATE : CARD_SHUT_POWERED_OFF
TIME STAMP    : Mar 15 2022 01:44:47
-------------------------------------------------------------------------------
DATE        TIME (UTC)  EVENT                    STATE
-------------------------------------------------------------------------------
Mar 15 2022 01:44:47    ev_powered_off           CARD_SHUT_POWERED_OFF
Mar 15 2022 01:44:47    transient_condition      CARD_SHUTDOWN
Mar 15 2022 01:44:47    ev_check_card_down_reaso CHECKING_DOWN_REASON
Mar 15 2022 01:44:47    ev_os_halted             OS_HALTED
Mar 15 2022 01:44:43    ev_factory_reset_done    FACTORY_RESET_DONE
Mar 15 2022 01:33:16    ev_factory_reset_started FACTORY_RESET_IN_PROGRESS
Mar 15 2022 01:33:11    ev_os_halting            OS_HALT_IN_PROGRESS
Mar 15 2022 01:33:10    ev_xr_shut               START_OS_HALT
Mar 15 2022 01:33:09    ev_ack_ok                STATE_NOT_CHANGED
Mar 15 2022 01:33:09    ev_graceful_shut         CARD_SHUTDOWN_IN_PROGRESS
Mar 15 2022 00:55:31    ev_xr_ready              XR_RUN
```

Commands

Use the **factory-reset** command for erasing the following folders of RP or line card:

- /misc/disk1
- /misc/scratch
- /var/log
- /misc/config

Run the following command through the console port of the router to erase customer-sensitive data in the RP or line card:

factory-reset { **reload** | **shutdown** } **location** *<location-id>* - erases customer-sensitive data in the specified location. Use the reload option in the command to reload the RP or line card after the factory reset and use the shutdown option to shut down the RP or line card after the factory reset.

Note Factory-reset logs are displayed on the console port of the node where the reset is performed.

The following steps explain how to reset your RP or line card to factory settings:

1. Erasing the RP or line card folder contents: Run the **factory-reset { reload | shutdown } location** command to delete the encryption keys and erase the customer-sensitive data from the RP or line card.

The following example shows how to perform the factory-reset shutdown command on an RP:

```
Router#factory-reset shutdown location 0/RP1/CPU0
Factory reset requested
Started punching watchdog
Started cleaning up mount point: /misc/scratch
Started syncing folder: /misc/scratch
Finished syncing folder: /misc/scratch
Finished cleaning up mount point: /misc/scratch
factory_reset_stop.sh
++++++++++++++++++++++++++++++++++++++++++++++
Started cleaning up mount point: /var/log
Started syncing folder: /var/log
Finished syncing folder: /var/log
Finished cleaning up mount point: /var/log
factory_reset_stop.sh
++++++++++++++++++++++++++++++++++++++++++++++
Started cleaning up mount point: /misc/disk1
Started syncing folder: /misc/disk1
Finished syncing folder: /misc/disk1
Finished cleaning up mount point: /misc/disk1
factory_reset_stop.sh
++++++++++++++++++++++++++++++++++++++++++++++
Started cleaning up folder: /misc/config
UTC 2022 Started syncing folder: /misc/config
Finished syncing folder: /misc/config
Finished cleaning up folder: /misc/config
factory_reset_stop.sh
++++++++++++++++++++++++++++++++++++++++++++++
Started cleaning up folder: /var/xr/enc/misc/config
/var/xr/enc/misc/config not present
Finished cleaning up folder: /var/xr/enc/misc/config
factory_reset_stop.sh
++++++++++++++++++++++++++++++++++++++++++++++
Started cleaning up folder: /mnt/rootfs/misc/config
/mnt/rootfs/misc/config not present
Finished cleaning up folder: /mnt/rootfs/misc/config
factory_reset_stop.sh
++++++++++++++++++++++++++++++++++++++++++++++
Encrypted logical volume does not exist. Nothing to remove.
/usr/local/etc/fpga-functions: line 797: 10912 Terminated
/usr/local/etc/punch-wd.sh
Stopped punching watchdog
```

The following example shows how to perform the factory-reset reload command on an RP:

```
Router#factory-reset reload location 0/RP1/CPU0
Factory reset requested
Started punching watchdog
Started cleaning up mount point: /misc/scratch
Started syncing folder: /misc/scratch
Finished syncing folder: /misc/scratch
Finished cleaning up mount point: /misc/scratch
++++++++++++++++++++++++++++++++++++++++++++++++
Started cleaning up mount point: /var/log
Started syncing folder: /var/log
Finished syncing folder: /var/log
Finished cleaning up mount point: /var/log
++++++++++++++++++++++++++++++++++++++++++++++++
Started cleaning up mount point: /misc/disk1
Started syncing folder: /misc/disk1
Finished syncing folder: /misc/disk1
Finished cleaning up mount point: /misc/disk1
```

```
++++++++++++++++++++++++++++++++++++++++++++++
Started cleaning up folder: /misc/config
Started syncing folder: /misc/config
Finished syncing folder: /misc/config
Finished cleaning up folder: /misc/config
++++++++++++++++++++++++++++++++++++++++++++++
Started cleaning up folder: /var/xr/enc/misc/config
/var/xr/enc/misc/config not present
Finished cleaning up folder: /var/xr/enc/misc/config
++++++++++++++++++++++++++++++++++++++++++++++
Started cleaning up folder: /mnt/rootfs/misc/config
/mnt/rootfs/misc/config not present
Finished cleaning up folder: /mnt/rootfs/misc/config
++++++++++++++++++++++++++++++++++++++++++++++
Encrypted logical volume does not exist. Nothing to remove.
/usr/local/etc/fpga-functions: line 790:  4137 Terminated
/usr/local/etc/punch-wd.sh
Stopped punching watchdog
```

2. Verifying factory reset: Use the **show shelfmgr history events location** command to verify the successful completion of the factory-reset in the standby RP or line card.

   The following example shows how to verify the factory-reset shutdown command:

```
RP/0/RP0/CPU0:Router#show shelfmgr history events location 0/RP1/CPU0
Tue Mar 15 01:45:56.402 UTC
NODE NAME     : 0/RP1/CPU0
CURRENT STATE : CARD_SHUT_POWERED_OFF
TIME STAMP    : Mar 15 2022 01:44:47
-------------------------------------------------------------------------------
DATE        TIME (UTC)  EVENT                    STATE
-------------------------------------------------------------------------------
Mar 15 2022 01:44:47    ev_powered_off           CARD_SHUT_POWERED_OFF
Mar 15 2022 01:44:47    transient_condition      CARD_SHUTDOWN
Mar 15 2022 01:44:47    ev_check_card_down_reaso CHECKING_DOWN_REASON
Mar 15 2022 01:44:47    ev_os_halted             OS_HALTED
Mar 15 2022 01:44:43    ev_factory_reset_done    FACTORY_RESET_DONE
Mar 15 2022 01:33:16    ev_factory_reset_started FACTORY_RESET_IN_PROGRESS
Mar 15 2022 01:33:11    ev_os_halting            OS_HALT_IN_PROGRESS
Mar 15 2022 01:33:10    ev_xr_shut               START_OS_HALT
Mar 15 2022 01:33:09    ev_ack_ok                STATE_NOT_CHANGED
Mar 15 2022 01:33:09    ev_graceful_shut         CARD_SHUTDOWN_IN_PROGRESS
Mar 15 2022 00:55:31    ev_xr_ready              XR_RUN
```

   The following example shows how to verify the factory-reset reload command:

```
RP/0/RP0/CPU0:Router#show shelfmgr history events location 0/RP0/CPU0
Tue Mar 15 01:45:56.402 UTC
NODE NAME     : 0/RP0/CPU0
CURRENT STATE : CARD_SHUT_POWERED_OFF
TIME STAMP    : Mar 15 2022 01:44:47
-------------------------------------------------------------------------------
DATE        TIME (UTC)  EVENT                    STATE
-------------------------------------------------------------------------------
Jun 29 2022 13:48:34    ev_xr_ready              XR_RUN
Jun 29 2022 13:48:10    ev_card_info_rcvd        CARD_INFO_RCVD
Jun 29 2022 13:47:52    ev_xr_init               XR_INITIALIZING
Jun 29 2022 13:47:44    ev_kernel_booting        STATE_NOT_CHANGED
Jun 29 2022 13:47:14    ev_kernel_booting        KERNEL_BOOTING
Jun 29 2022 13:46:53    ev_unmapped_event        STATE_NOT_CHANGED
Jun 29 2022 13:46:53    ev_bios_started          BIOS_STARTED
Jun 29 2022 13:46:51    ev_bios_ready            BIOS_READY
Jun 29 2022 13:46:10    ev_unmapped_event        STATE_NOT_CHANGED
```

```
Jun 29 2022 13:46:10    ev_powered_on            CARD_POWERED_ON
Jun 29 2022 13:46:05    ev_card_reset_done       CARD_RESET
Jun 29 2022 13:46:05    transient_condition      CARD_RESETTING
Jun 29 2022 13:46:05    ev_check_card_down_reaso CHECKING_DOWN_REASON
Jun 29 2022 13:46:05    ev_os_halted             OS_HALTED
Jun 29 2022 13:45:50    ev_factory_reset_done    FACTORY_RESET_DONE
Jun 29 2022 13:34:09    ev_factory_reset_started FACTORY_RESET_IN_PROGRESS
Jun 29 2022 13:33:59    ev_os_halting            OS_HALT_IN_PROGRESS
Jun 29 2022 13:33:58    ev_xr_shut               START_OS_HALT
Jun 29 2022 13:33:56    ev_graceful_reload       CARD_SHUTDOWN_IN_PROGRESS
Jun 29 2022 09:18:43    ev_xr_ready              XR_RUN
Jun 29 2022 09:17:37    ev_card_info_rcvd        CARD_INFO_RCVD
Jun 29 2022 09:17:32    ev_powered_on            CARD_POWERED_ON
Jun 29 2022 09:17:31    init                     CARD_DISCOVERED
```

Excluding Sensitive Information in Show Running Configurations Output

Table 24: Feature History Table

Feature Name	Release Information	Feature Description
Excluding Sensitive Information in Show Running Configurations Command Output	Release 7.5.4	You can now exclude sensitive information such as strings, usernames, passwords, comments, or IP addresses within the **show running-configuration** command output by enabling sanitization on the nonvolatile generation (NVGEN) process. With this feature, you can achieve better data protection to prevent cybersecurity risks compared to regular router algorithms. This feature introduces the **nvgen default-sanitize** command.

The **show running configuration** command uses the nonvolatile generation (NVGEN) process in IOS-XR software to collect configuration information from every system component and construct a running configuration file to create its output. However, this file may contain sensitive information, including usernames, passwords, and IP addresses, which could pose a security threat when obfuscation algorithms in the router are weak compared to modern cryptographic standards.

In this feature, you can mask the following types of sensitive information in the show running configurations:

- Strings
- Usernames
- Passwords
- Comments

- IP Addresses

On enabling the sanitization in show running configurations, the NVGEN process replaces the corresponding information with **<removed>** string. For example, if you enable sanitization for IP Addresses, the show running configuration includes the **<removed>** string in place of all the IP Addresses in the output.

Sanitizing Strings

Configuration

```
Router# config
Router:(config)# nvgen default-sanitize strings
Router:(config)# commit
```

Running Configuration

```
Router# show run nvgen
nvgen
 default-sanitize strings
!
```

Verification

```
Router# show run int Hu0/2/0/4
interface HundredGigE0/2/0/4
 ! This is comment 1
 description <removed>
 !
```

Sanitizing Usernames

Configuration

```
Router# config
Router:(config)# nvgen default-sanitize usernames
Router:(config)# commit
```

Running Configuration

```
Router# show run nvgen
nvgen
 default-sanitize usernames
!
```

Verification

```
Router# show run username test
username <removed>
 group root-lr
 password 7 172864HJWBJHBCWH
!
```

Sanitizing Passwords

Configuration

```
Router# config
Router:(config)# nvgen default-sanitize passwords
Router:(config)# commit
```

Running Configuration

```
Router# show run nvgen
nvgen
```

```
 default-sanitize passwords
!
```

Verification

```
Router# show run username test
username test
 group root-lr
 password 7 <removed>
!
```

Sanitizing Comments

Configuration

```
Router# config
Router:(config)# nvgen default-sanitize comments
Router:(config)# commit
```

Running Configuration

```
Router# show run nvgen
nvgen
 default-sanitize comments
!
```

Verification

```
Router# show run int Hu0/2/0/4
interface HundredGigE0/2/0/4
 ! <comments removed>
 description This is bundle member
 !
```

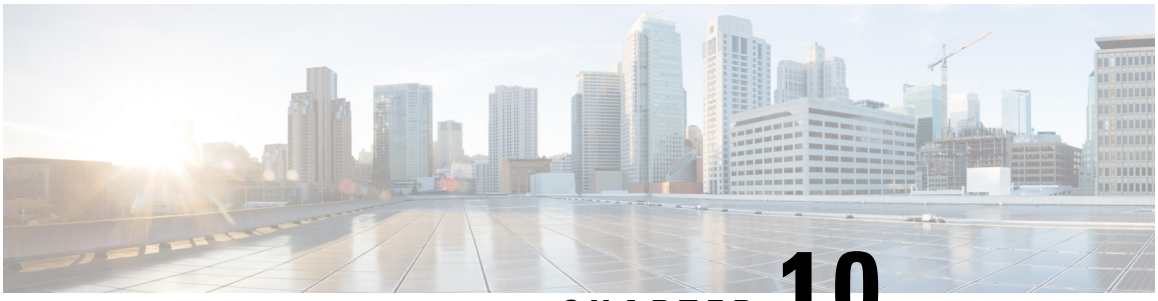
Sanitizing IP Addresses

Configuration

```
Router# config
Router:(config)# nvgen default-sanitize ipaddrs
Router:(config)# commit
```

Verification

```
Router# show run int Hu0/2/0/4
interface HundredGigE0/2/0/4
 ! This is comment 1
 description This is bundle member
  ipv4 address <removed> <removed>
!
```



CHAPTER 10

Configuring Frequency Synchronization

Table 25: Feature History Table

Feature name	Release Information	Feature Description
Synchronous Ethernet (SyncE) Support on 88-LC0-36FH-M Line card and 8202-32FH-M Router	Release 7.5.2	With this release, support for Synchronous Ethernet (SyncE) ITU-T profiles G.8262 and G.8264 is extended to the following: • 88-LC0-36FH-M line card • 8202-32FH-M router The SyncE profile G.8262 enables synchronous ethernet clock support and the SyncE profile G.8264 enables ethernet synchronization messaging channel (ESMC).
Support for Frequency Synchronization	Release 7.3.1	Based on the ITU-T G.8262 recommendations, precision frequency is enabled on timing devices to deliver frequency synchronization for bandwidth, frequency accuracy, holdover, and measure noise generation. This support allows for correct network operations when synchronous equipment is timed from either another synchronous equipment clock or a higher-quality clock.

Overview

Frequency synchronization is the ability to distribute precision frequency around a network. In this context, timing refers to precision frequency, not an accurate time of day. Precision frequency is required in next generation networks for applications such as circuit emulation.

To achieve compliance to ITU specifications for TDM, differential method circuit emulation must be used, which requires a known, common precision frequency reference at each end of the emulated circuit. This is used in conjunction with an external timing technology to provide synchronization of precision timing across the network.

SDH equipments are widely replaced by Ethernet equipments and synchronized frequency is required over such Ethernet ports. Synchronous Ethernet (SyncE) is used to accurately synchronize frequency in devices connected by Ethernet in a network. SyncE provides level frequency distribution of known common precision frequency references to a physical layer Ethernet network.

To maintain SyncE links, a set of operational messages are required. These messages ensure that a node is always deriving timing information from the most reliable source and then transfers the timing source quality information to clock the SyncE link.

Source and Selection Points

Frequency Synchronization implementation involves Sources and Selection Points.

A Source inputs frequency signals into a system or transmits them out of a system. There are four types of sources:

- Line interfaces. This includes SyncE interfaces.
- Clock interfaces. These are external connectors for connecting other timing signals, such as BITS and GPS.
- PTP clock. If IEEE 1588 version 2 is configured on the router, a PTP clock may be available to frequency synchronization as a source of the time-of-day and frequency.
- Internal oscillator. This is a free-running internal oscillator chip.

Each source has a Quality Level (QL) associated with it which gives the accuracy of the clock. This provides information about the best available source the devices in the system can synchronize to. To define a predefined network synchronization flow and prevent timing loops, you can assign priority values to the sources on each router. The combination of QL information and user-assigned priority levels allow each router to choose a source to synchronize its SyncE interfaces, as described in the ITU standard G.781.

A Selection Point is any point where a choice is made between several frequency signals and possibly one or many of them are selected. Selection points form a graph representing the flow of timing signals between different cards in a router running Cisco IOS XR software. For example, there can be one or many selection points between different Synchronous Ethernet inputs available on a single line card. This information is forwarded to a selection point on the router, to choose between the selected source from each card.

The input signals to the selection points can be:

- Received directly from a source.
- Received as the output from another selection point on the same card.
- Received as the output from a selection point on a different card.

The output of a selection point can be used in a number of ways, like:

- To drive the signals sent out of a set of interfaces.
- As input into another selection point on a card.
- As input into a selection point on an another card.

Use **show frequency synchronization selection** command to see a detailed view of the different selection points within the system.

Note

- We recommend you to configure, and enable Frequency Synchronization selection input on two interfaces per line card.
- For link aggregation, you must configure and enable Frequency Synchronization selection input on a single bundle member.

SyncE Profiles Support Matrix

This table provides information on the SyncE profiles that are supported on the Cisco 8000 series routers and line cards.

Table 26: SyncE Profiles Support Matrix

Hardware Module	Supported SyncE profiles	Cisco IOS XR Release
8000-RP2 Route Processor	G8275.1 G8273.2	Release 7.11.1
	G8275.1 G8273.2	Release 7.11.1
88-LC0-36FH-M	G8275.1 G8273.2	Release 7.11.1
8800-LC-36FH	G8275.1 G8273.2	Release 7.11.1
• 88-LC0-36FH-M line card • 8202-32FH-M router	G.8262	Release 7.5.2
	G.8264	
• 8201-32FH router • 88-LC-34H14FH line card • 88-LC0-36FH line card	G.8262	Release 7.3.3
	G.8264	

Hardware Module	Supported SyncE profiles	Cisco IOS XR Release
• 8800-LC-36FH line card • 8800-LC-48FH line card • 8202 router • 8201 router	G.8262 G.8264	Release 7.3.1

SyncE Restrictions

This section lists a restriction in configuring frequency synchronization.

- SyncE is not supported on 8800-RP 1588 ports.

Enabling Frequency Synchronization on the Router

This task describes the router-level configuration required to enable frequency synchronization.

Note If timing mode system is not configured, the major alarm `T4 PLL is in FREERUN mode` is raised. This alarm has no functional impact to the system behavior.

SUMMARY STEPS

1. **configure**
2. **frequency synchronization**
3. **clock-interface timing-mode** {**independent** | **system**
4. **quality itu-t option** {**1** | **2 generation** {**1** | **2**}}
5. **log selection** {**changes** | **errors**}
6. Use one of these commands:
   - **end**
   - **commit**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure** **Example:** `RP/0/RP0/CPU0:router# configure`	Enters mode.
Step 2	**frequency synchronization** **Example:**	Enables frequency synchronization on the router.

	Command or Action	Purpose
	`Router(config)# frequency synchronization`	
Step 3	**clock-interface timing-mode** {**independent** | **system** **Example:** `Router(config-freqsync)# clock-interface timing-mode system`	Configures the type of timing sources that can be used to drive the output from a clock interface. If this command is not used, the default quality mode is used. In the default mode, the clock interface output is driven only by input from line interfaces and the internal oscillator; it is never driven by input from another clock interface. In addition, some heuristic tests are run to detect if the signal being sent out of one clock interface can be looped back by some external box and sent back in via the same, or another clock interface. • **independent**—Specifies that the output of clock interfaces is driven only by the line interfaces (SyncE), as in the default mode. Loopback detection is disabled. • **system**—Specifies that the output of a clock interface is driven by the system-selected timing source (the source used to drive all SyncE interfaces), including clock interfaces. Loopback detection is disabled.
Step 4	**quality itu-t option** {**1** | **2 generation** {**1** | **2**}} **Example:** `Router(config-freqsync)# quality itu-t option 2 generation 1`	(Optional) Specifies the quality level for the router. The default is **option 1**. • **option 1**—Includes PRC, ePRTC, PRTC, SSU-A, SSU-B, SEC, eEEC, and DNU. • **option 2 generation 1**—Includes PRS, ePRTC, PRTC, STU, ST2, ST3, SMC, ST4, eEEC, and DUS. • **option 2 generation 2**—Includes PRS, ePRTC, PRTC, STU, ST2, ST3, ST3E, SMC, ST4,XeEEC, and DUS. **Note** `The quality option configured here must match the quality option specified in the **quality receive** and **quality transmit** commands in interface frequency synchronization configuration mode.
Step 5	**log selection** {**changes** | **errors**} **Example:** `Router(config-freqsync)# log selection changes`	Enables logging to frequency synchronization. • **changes**—Logs every time there is a change to the selected source, in addition to errors. • **errors**—Logs only when there are no available frequency sources, or when the only available frequency source is the internal oscillator.
Step 6	Use one of these commands: • **end** • **commit**	Saves configuration changes. • When you issue the **end** command, the system prompts you to commit changes:

	Command or Action	Purpose

	Example:
	`Router(config-freqsync)# end`
	or
	`Router(config-freqsync)# commit`
		`Uncommitted changes found, commit them before exiting(yes/no/cancel)? [cancel]:`
		• Entering **yes** saves configuration changes to the running configuration file, exits the configuration session, and returns the router to EXEC mode.
		• Entering **no** exits the configuration session and returns the router to EXEC mode without committing the configuration changes.
		• Entering **cancel** leaves the router in the current configuration session without exiting or committing the configuration changes.
		• Use the **commit** command to save the configuration changes to the running configuration file, and remain within the configuration session.

What to do next

Configure frequency synchronization on any interfaces that should participate in frequency synchronization.

Configuring Frequency Synchronization on an Interface

By default, there is no frequency synchronization on line interfaces. Use this task to configure an interface to participate in frequency synchronization.

Before you begin

You must enable frequency synchronization globally on the router.

SUMMARY STEPS

1. **configure**
2. **interface** *type interface-path-id*
3. **frequency synchronization**
4. **selection input**
5. **priority** *priority-value*
6. **wait-to-restore** *minutes*
7. **ssm disable**
8. **time-of-day-priority** *priority*
9. **quality transmit** {**exact** | **highest** | **lowest**} **itu-t option** *ql-option*
10. **quality receive** {**exact** | **highest** | **lowest**} **itu-t option** *ql-option*
11. Use one of these commands:
    - **end**

- **commit**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure** **Example:** `RP/0/RP0/CPU0:router# configure`	Enters mode.
Step 2	**interface** *type interface-path-id* **Example:** `Router(config)# interface HundredGigE 0/1/1/0`	Enters interface configuration mode.
Step 3	**frequency synchronization** **Example:** `Router(config-if)# frequency synchronization`	Enables frequency synchronization on the interface and enters interface frequency synchronization mode to configure the various options. By default, this causes the system selected frequency signal to be used for clocking transmission, but does not enable the use of the interface as an input.
Step 4	**selection input** **Example:** `Router(config-if-freqsync)# selection input`	(Optional) Specifies the interface as a timing source to be passed to the selection algorithm.
Step 5	**priority** *priority-value* **Example:** `Router(config-if-freqsync)# priority 100`	(Optional) Configures the priority of the frequency source on a controller or an interface. Values can range from 1 (highest priority) to 254 (lowest priority). The default value is 100. This command is used to set the priority for an interface or clock interface. The priority is used in the clock-selection algorithm to choose between two sources that have the same quality level (QL). Lower priority values are preferred.
Step 6	**wait-to-restore** *minutes* **Example:** `Router(config-if-freqsync)# wait-to-restore 300`	(Optional) Configures the wait-to-restore time, in minutes, for frequency synchronization on an interface. This is the amount of time after the interface comes up before it is used for synchronization. Values can range from 0 to 12. The default value is 5.
Step 7	**ssm disable** **Example:** `Router(config-if-freqsync)# ssm disable`	(Optional) Disables Synchronization Status Messages (SSMs) on the interface. • For SyncE interfaces, this disables sending ESMC packets, and ignores any received ESMC packets. • For clock interfaces, this causes DNUs to be sent, and ignores any received QL value.

	Command or Action	Purpose
Step 8	**time-of-day-priority** *priority* **Example:** `RP/0/RP0/CPU0:router(config-if-freqsync)# time-of-day-priority 50`	(Optional) Specifies the priority of this time source as the time-of-day (ToD) source. The priority is used as the first criterion when selecting between sources for a time-of-day selection point. Values can range from 1 (highest priority) to 254 (lowest priority); the default value is 100.
Step 9	**quality transmit** {**exact** | **highest** | **lowest**} **itu-t option** *ql-option* **Example:** `Router(config-clk-freqsync)# quality transmit highest itu-t option 1 prc`	(Optional) Adjusts the QL that is transmitted in SSMs. • **exact** *ql*—Specifies the exact QL to send, unless DNU would otherwise be sent. • **highest** *ql*—Specifies an upper limit on the QL to be sent. If the selected source has a higher QL than the QL specified here, this QL is sent instead. • **lowest** *ql*—Specifies a lower limit on the QL to be sent. If the selected source has a lower QL than the QL specified here, DNU is sent instead. The quality option specified in this command must match the globally-configured quality option in the **quality itu-t option** command. **Note** For clock interfaces that do not support SSM, only the lowest QL can be specified. In this case, rather than sending DNU, the output is squelched, and no signal is sent.
Step 10	**quality receive** {**exact** | **highest** | **lowest**} **itu-t option** *ql-option* **Example:** `Router(config-clk-freqsync)# quality receive highest itu-t option 1 prc`	(Optional) Adjusts the QL value that is received in SSMs, before it is used in the selection algorithm. • **exact** *ql*—Specifies the exact QL regardless of the value received, unless the received value is DNU. • **highest** *ql*—Specifies an upper limit on the received QL. If the received value is higher than this specified QL, this QL is used instead. • **lowest** *ql*—Specifies a lower limit on the received QL. If the received value is lower than this specified QL, DNU is used instead. The quality option specified in this command must match the globally-configured quality option in the **quality itu-t option** command. **Note** For clock interfaces that do not support SSM, only the exact QL can be specified.
Step 11	Use one of these commands: • **end** • **commit**	Saves configuration changes. • When you issue the **end** command, the system prompts you to commit changes:

	Command or Action	Purpose

	Example:
	`Router(config-if-freqsync)# end`
	or
	`Router(config-if-freqsync)# commit`
		`Uncommitted changes found, commit them before exiting(yes/no/cancel)? [cancel]:`
		• Entering **yes** saves configuration changes to the running configuration file, exits the configuration session, and returns the router to EXEC mode.
		• Entering **no** exits the configuration session and returns the router to EXEC mode without committing the configuration changes.
		• Entering **cancel** leaves the router in the current configuration session without exiting or committing the configuration changes.
		• Use the **commit** command to save the configuration changes to the running configuration file, and remain within the configuration session.

Configuring Frequency Synchronization on a Clock Interface

External Timing Source

Clock interfaces are external connectors for connecting other timing signals, such as, GPS, BITS.

GPS

The router can receive 1PPS, 10 MHz, and ToD signals from an external clocking and timing source. The three inputs are combined as a Sync-2 interface to form the external timing source or the GPS input.

The GPS front panel connector details are:

- ToD—RS422 format as input
- 1PPS—RS422 or DIN connector as input
- 10MHz—DIN connector as input

GPS input starts only when all the three signals – 1PPS, 10MHz, and ToD are UP.

Note Unlike the Ethernet interface, the Sync-2 interface cannot receive or transmit QL. Ensure that you assign a QL value to the Sync-2 interface.

By default, 1PPS and 10MHz are in output mode. ToD output mode is not configurable.

For the variant, 8800-RP, 10MHZ and 1PPS can operate in output mode only when PTP Slave or BC mode are configured.

Note Both RP0 and RP1 should have identical configurations and should be connected to same external reference for sync 0 and sync 2 to meet phase transient response compliance standards during RP failover.

Configuring GPS Settings for the Grandmaster Clock

```
Router# configure
Router(config)# clock-interface sync 2 location 0/RP0/CPU0
Router(config-clock-if)# port-parameters
Router(config-clk-parms)# gps-input tod-format cisco pps-input ttl
Router(config-clk-parms)# exit
Router(config-clock-if)# frequency synchronization
Router(config-clk-freqsync)# selection input
Router(config-clk-freqsync)# wait-to-restore 0
Router(config-clk-freqsync)# quality receive exact itu-t option 1 PRC
Router(config-clk-freqsync)# exit
Router(config-clock-if)# frequency synchronization
Router(config-clk-freqsync)# quality itu-t option 1
Router(config-clk-freqsync)# clock-interface timing-mode system
Router(config-clk-freqsync)# end
```

Verifying the GPS Input

```
Router# show controllers timing controller clock

SYNCC Clock-Setting: -1 -1 6 -1
             Port 0    Port 1    Port 2    Port 3
Config :     No        No        Yes       No
Mode :       -         -         GPS       -
Submode1 :   -         -         CISCO     -
Submode2 :   -         -         UTC       -
Submode3 :   0         0         0         0
Shutdown :   0         0         0         0
Direction :  RX/TX     RX/TX     RX        RX/TX
Baud-Rate :  -         -         9600      -
QL Option :  O1        O1        -         -
RX_ssm(raw): -         -         -         -
TX_ssm :     -         -         -         -
If_state :   DOWN      DOWN      UP        DOWN  << Port 2 is UP when GPS input is valid.
```

When the front panel timing LED is Green, it indicates that the GPS is configured and 1PPS, ToD, and 10M iputs are valid.

Timing GPS LED Behavior:

- Timing GPS LED is off: Indicates no GPS is configured or the GPS port is down.
- Timing GPS LED is green: Indicates the GPS port is up.

SYNC LED Behavior:

- SYNC LED is green: Indicates that time core is synchronized to either external source, or SyncE or 1588.
- SYNC LED is amber: Indicates a Holdover or Acquiring state.
- SYNC LED is off: Indicates synchronization in disable or free-running state.

The following table desribes the implication of LED light status of GPS, BITS port, and SYNC LEDs.

Table 27: LED Light States

LED Type	LED State	Description
GPS	Green	The GPS interface is provisioned and frequency, time of day, and phase input is operating accurately.
	Off	The GPS interface is not provisioned or the GPS input is not operating accurately.
BITS port	Green	The BITS interface is provisioned and frequency is operating accurately.
	Off	The BITS interface is not provisioned or the BITS input is not operating accurately.
SYNC	Green	The frequency, time, and phase are synchronized to an external interface. The external interface can be: • BITS • GPS • Recovered RX clock
	Amber	The sytem is running in holdover or free-run mode and based on user configuration it is not synchronized to an external interface, as expected.
	Off	The centralized frequency or time and phase distribution is not enabled. Therefore, all clocking is based on the local oscillator on the RSP.

Building Integrated Timing Supply

Router supports receiving (Rx) and transmitting (Tx) of frequency via BITS interface. To receive and transmit BITS signals, configuration is done under the clock-interface sync 0 on the route processor (RP).

Note Both RP0 and RP1 should have identical configurations and should be connected to same external reference for sync 0 and sync 2 to meet phase transient response compliance standards during RP failover.

Prerequisite for BITS

Frequency synchronization must be configured with the required quality level option at the global level.

```
Router# show running-config frequency synchronization
Wed Aug 21 12:37:32.524 UTC
frequency synchronization
 quality itu-t option 1
!
```

Note BITS-In and BITS-Out on the peer nodes must be configured with the same mode and format.

Configuring BITS-IN

```
Router# configure
Wed Aug 21 12:29:59.162 UTC
Router(config)# clock-interface sync 0 location 0/RP0/CPU0
Router(config-clock-if)# port-parameters
Router(config-clk-parms)# bits-input e1 crc-4 sa4 ami
Router(config-clk-parms)# exit
Router(config-clock-if)# frequency synchronization
Router(config-clk-freqsync)# selection input
Router(config-clk-freqsync)# wait-to-restore 0
Router(config-clk-freqsync)# priority 1
Router(config-clk-freqsync)# commit
Wed Aug 21 12:30:53.296 UTC

Router# show running-config clock-interface sync 0 location 0/RP0/CPU0
Wed Aug 21 12:31:43.350 UTC
clock-interface sync 0 location 0/RP0/CPU0
 port-parameters
  bits-input e1 crc-4 sa4 ami
 !
 frequency synchronization
  selection input
  priority 1
  wait-to-restore 0
 !
!
```

Configuring BITS-OUT

```
Router# configure
Wed Aug 21 12:53:24.189 UTC
Router(config)# clock-interface sync 0 location 0/RP0/CPU0
Router(config-clock-if)# port-parameters
Router(config-clk-parms)# bits-output e1 crc-4 sa4 ami
Router(config-clk-parms)# commit
Wed Aug 21 12:53:39.411 UTC

Router# show running-config clock-interface sync 0 location 0/RP0/CPU0
Wed Aug 21 12:54:02.853 UTC
clock-interface sync 0 location 0/RP0/CPU0
 port-parameters
  bits-output e1 crc-4 sa4 ami
 !
!
```

Note Based on the quality level chosen in global configuration, E1/T1 modes can be changed as required. But in all the cases, both TX and RX side modes and submodes must be the same.

For non-CRC-4/D4 modes, SSM is not present in BITS and manual receive quality level must be configured.

Verifying BITS-IN Configuration

```
Router# show controllers timing controller clock
Wed Aug 21 12:38:20.394 UTC

SYNCC Clock-Setting: 1 -1 -1 -1

          Port 0          Port 1          Port 2          Port 3
Config     : Yes            No              No              No
Mode       : E1             -               -               -
Submode1   : CRC-4          -               -               -
Submode2   : AMI            -               -               -
Submode3   : 0              0               0               0
Shutdown   : 0              0               0               0
Direction  : RX             RX/TX           RX/TX           RX/TX
Baud-Rate  : -              -               -               -
QL Option  : O1             O1              -               -
RX_ssm(raw): 99             -               -               -
TX_ssm     : -              -               -               -
If_state   : UP           DOWN            DOWN            DOWN
```

Verifying BITS-OUT Configuration

```
Router# show controllers timing controller clock
Wed Aug 21 12:49:32.923 UTC
SYNCC Clock-Setting: 1 -1 -1 -1

          Port 0          Port 1          Port 2          Port 3
Config     : Yes            No              No              No
Mode       : E1             -               -               -
Submode1   : CRC-4          -               -               -
Submode2   : AMI            -               -               -
Submode3   : 0              0               0               0
Shutdown   : 0              0               0               0
Direction  : TX             RX/TX           RX/TX           RX/TX
Baud-Rate  : -              -               -               -
QL Option  : O1             O1              -               -
RX_ssm(raw): -              -               -               -
TX_ssm     : 22             -               -               -
If_state   : UP             DOWN            DOWN            DOWN
```

Verify Quality Level Received and Clock Interfaces

```
Router# show frequency synchronization clock-interfaces brief
Tue Feb 23 23:42:22.654 UTC
Flags: > - Up               D - Down                        S - Assigned for selection
d - SSM Disabled            s - Output squelched            L - Looped back
Node 0/RP0/CPU0:
==============
Fl      Clock Interface       QLrcv    QLuse    Pri   QLsnd    Output driven by
=====   ==================    ======   ======   ===   ======   ========================
D       Sync0                 n/a      n/a      n/a   n/a      n/a
D       Sync1                 n/a      n/a      n/a   n/a      n/a
>S      Sync2                 None     PRC      100   n/a      n/a
>S      Internal0             n/a      SEC      255   n/a      n/a
```

```
Node 0/RP1/CPU0:
==============
Fl      Clock Interface       QLrcv    QLuse    Pri   QLsnd     Output driven by
=====   ==================    ======   ======   ===   ======    ========================
D       Sync0                 n/a      n/a      n/a   n/a       n/a
D       Sync1                 n/a      n/a      n/a   n/a       n/a
D       Sync2                 n/a      n/a      n/a   n/a       n/a
>S      Internal0             n/a      SEC      255   n/a       n/a
```

Verifying the Frequency Synchronization Configuration

After performing the frequency synchronization configuration tasks, use this task to check for configuration errors and verify the configuration.

SUMMARY STEPS

1. **show frequency synchronization configuration-errors**
2. **show frequency synchronization interfaces brief**
3. **show frequency synchronization interfaces** *node-id*
4. **show processes fsyncmgr location** *node-id*

DETAILED STEPS

Step 1 show frequency synchronization configuration-errors

Example:

```
Router# show frequency synchronization configuration-errors

Node 0/2/CPU0:
==============
  interface HundredGigE 0/2/0/0 frequency synchronization
    * Frequency synchronization is enabled on this interface, but isn't enabled globally.

  interface HundredGigE 0/2/0/0 frequency synchronization quality transmit exact itu-t option 2
generation 1 PRS
    * The QL that is configured is from a different QL option set than is configured globally.
```

Displays any errors that are caused by inconsistencies between shared-plane (global) and local-plane (interface) configurations. There are two possible errors that can be displayed:

- Frequency Synchronization is configured on an interface (line interface or clock-interface), but is not configured globally. Refer to Enabling Frequency Synchronization on the Router, on page 148
- The QL option configured on some interface does not match the global QL option. Under an interface (line interface or clock interface), the QL option is specified using the **quality transmit** and **quality receive** commands. The value specified must match the value configured in the global **quality itu-t option** command, or match the default (option 1) if the global **quality itu-t option** command is not configured.

Once all the errors have been resolved, meaning there is no output from the command, continue to the next step.

Step 2 show frequency synchronization interfaces brief

Example:

```
Router# show frequency synchronization interfaces brief

Flags:  > - Up                D - Down              S - Assigned for selection
        d - SSM Disabled      x - Peer timed out    i - Init state

Fl  Interface                QLrcv QLuse Pri QLsnt Source
=== ======================== ===== ===== === ===== ======================
>Sx HundredGigE 0/2/0/0   Fail  Fail  100 DNU   None
Dd  HundredGigE 0/2/0/1   n/a   Fail  100 n/a   None

Router# show frequency synchronization clock-interfaces brief

Flags:  > - Up                D - Down              S - Assigned for selection
        d - SSM Disabled      s - Output squelched  L - Looped back

Node 0/0/CPU0:
==============
  Fl    Clock Interface     QLrcv  QLuse  Pri QLsnd  Source
  ===== ================== ====== ====== === ====== ========================
  >S    Sync0               PRC    Fail   100 SSU-B  Internal0 [0/0/CPU0]
  >S    Internal0           n/a    SSU-B  255 n/a    None

Node 0/1/CPU0:
==============
  Fl    Clock Interface     QLrcv  QLuse  Pri QLsnd  Source
  ===== ================== ====== ====== === ====== ========================
  D     Sync0               None   Fail   100 SSU-B  Internal0 [0/1/CPU0]
  >S    Internal0           n/a    SSU-B  255 n/a    None
```

Verifies the configuration. Note the following points:

- All line interface that have frequency synchronization configured are displayed.
- All clock interfaces and internal oscillators are displayed.
- Sources that have been nominated as inputs (in other words, have **selection input** configured) have ‘S’ in the Flags column; sources that have not been nominated as inputs do not have ‘S’ displayed.

  Note Internal oscillators are always eligible as inputs.

- ‘>’ or ‘D’ is displayed in the flags field as appropriate.

If any of these items are not true, continue to the next step.

Step 3 **show frequency synchronization interfaces** *node-id*

Example:

```
Router# show frequency synchronization interfaces HundredGigE 0/2/0/2

Interface HundredGigE 0/2/0/2 (shutdown)
  Assigned as input for selection
  SSM Enabled
  Input:
    Down
    Last received QL: Failed
    Effective QL:     Failed, Priority: 100
  Output:
    Selected source:    Sync0 [0/0/CPU0]
```

```
    Selected source QL: Opt-I/PRC
    Effective QL:       Opt-I/PRC
  Next selection points: LC_INGRESS

Router# show frequency synchronization clock-interfaces location 0/1/CPU0

Node 0/1/CPU0:
==============
  Clock interface Sync0 (Down: mode not configured)
    SSM supported and enabled
    Input:
      Down
      Last received QL: Opt-I/PRC
      Effective QL:     Failed, Priority: 100
    Output:
      Selected source:    Internal0 [0/1/CPU0]
      Selected source QL: Opt-I/SSU-B
      Effective QL:       Opt-I/SSU-B
  Next selection points: RP_SYSTEM

  Clock interface Internal0 (Up)
    Assigned as input for selection
    Input:
      Default QL:   Opt-I/SSU-B
      Effective QL: Opt-I/SSU-B, Priority: 255
  Next selection points: RP_SYSTEM RP_CLOCK_INTF
```

Investigates issues within individual interfaces. If the clock interface is down, a reason is displayed. This may be because there is missing or conflicting platform configuration on the clock interface.

Step 4 **show processes fsyncmgr location** *node-id*

Example:

```
Router# show processes fsyncmgr location 0/0/CPU0

                  Job Id: 134
                     PID: 30202
         Executable path: /pkg/bin/fsyncmgr
              Instance #: 1
              Version ID: 00.00.0000
                 Respawn: ON
           Respawn count: 1
  Max. spawns per minute: 12
            Last started: Mon Mar  9 16:30:43 2009
           Process state: Run
           Package state: Normal
       Started on config: cfg/gl/freqsync/g/a/enable
                    core: MAINMEM
                Max. core: 0
                Placement: None
             startup_path: /pkg/startup/fsyncmgr.startup
                   Ready: 0.133s
        Process cpu time: 1730768.741 user, -133848.-361 kernel, 1596920.380 total
  ----------------------------------------------------------------------------
```

Verifies that the fsyncmgr process is running on the appropriate nodes.

Support for ITU-T G.8264 Standard

Table 28: Feature History Table

Feature name	Release Information	Feature Description
Support for ITU-T G.8264 Standard	Release 7.3.1	The Ethernet Synchronization Message Channel (ESMC) protocol is specified in the ITU-T G.8264 performance compliance standard. It provides recommendations on synchronizing clock frequency across a network over an Ethernet port, along with the ability to select quality levels. The G.8264 standard provides a new extended Quality Level (QL) of Type Length Value (TLV). As Ethernet equipment gradually replace SONET and SDH equipment in service provider networks, frequency synchronization provides high-quality clock synchronization over Ethernet ports.

The Ethernet Synchronization Message Channel (ESMC) protocol specified in the ITU-T G.8264 enables the synchronization of clock frequency across a network over Ethernet ports with the ability to select enhanced quality levels. Enhanced quality levels lead to improved bandwidth, frequency accuracy, and holdover along with reduced noise generation in a network.

As part of the ESMC protocol, the quality level (QL) of timing signals is distributed through Synchronization Status Messages (SSMs). The updated G.8264 standard provides a new and enhanced Quality Level (QL) of Type Length Value (TLV) that allows more precise quality to provide accurate clocks.

The new and enhanced QL of TLV that is part of the updated G.8264 standard is known as enhanced SyncE (eSyncE). The enhanced QL of TLV enables support for more QL values. You can configure a router to send or receive the enhanced TLV. The enhanced QL of TLV results in more precise synchronization of clocks across a network. To enable this feature, the local clock ID is configured. The clock ID is used, when appropriate, in the extended QL TLVs

Note Default clock ID is based on the MAC address of the chassis.

Restrictions

There may be devices in a network that do not support eSyncE and also do not support enhanced ESMC. If a router does not support eSyncE, it ignores any enhanced TLVs it receives and does not support enhanced quality to provide accurate clocks. Such routers at ingress nodes drop the QL TLV received from the previous node supporting eSyncE. If the next node supports enhanced ESMC, then the extended QL TLV is applied afresh to that node.

Configuration

1. Configure frequency synchronization on the router.
2. Configure the MAC address of the device clock that can transmit the enhanced QL TLV in the network.
3. Configure frequency synchronization on an interface.
4. Configure the quality level options to be transmitted by the device clock.

Configuration Example

```
/* Configure frequency synchronization on the router. */
Router# configure
Router(config)# frequency synchronization

/* Configure the MAC address of the clock that can transmit the enhanced QL TLV in the
network. */
Router(config-freqsync)# clock-id mac-address 0000.0001.0003
Router(config-freqsync)# commit
Router(config-freqsync)# exit

/* Configure frequency synchronization on an interface. */
Router(config)# interface HundredGigE 0/1/0/0
Router(config-if)# frequency synchronization

/* Configure the quality level options to be transmitted by the device clock. */
Router(config-if-freqsync)# quality transmit exact itu-t option 1 ePRTC
```

Running Configuration

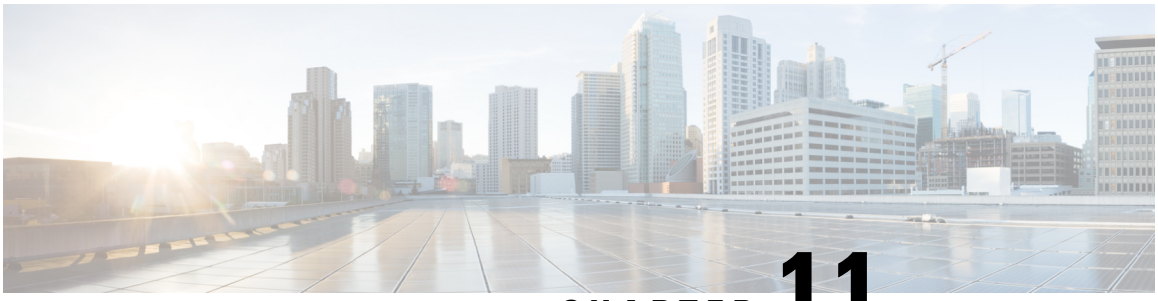
```
Router# show running-config
frequency synchronization
 clock-identity mac-address 0000.0001.0003
!
interface preconfigure HundredGigE 0/1/0/0
 frequency synchronization
  quality transmit exact itu-t option 1 ePRTC
 !
!
```

Verification

To verify if eSyncE is configured, use the **show frequency synchronization interfaces** command.

```
Router# show frequency synchronization interfaces
Interface HundredGigE 0/11/0/1 (up)
  Assigned as input for selection
  Wait-to-restore time 0 minutes
  SSM Enabled
    Peer Up for 00:00:54, last SSM received 0.741s ago
    Peer has come up 1 times and timed out 0 times
    ESMC SSMs        Total  Information     Event    DNU/DUS
      Sent:             55           53         2         45
      Received:         55           55         0          0
  Input:
    Up
    Last received QL: Opt-I/ePRTC
    Effective QL: Opt-I/ePRTC, Priority: 30, Time-of-day Priority 100
    Originator clock ID: aaaabbfffebbcccc
    SyncE steps: 1, eSyncE steps: 1
```

```
  All steps run eSyncE; Chain of extended ESMC data is complete
  Supports frequency
Output:
  Selected source: HundredGigE 0/11/0/1
  Selected source QL: Opt-I/ePRTC
  Effective QL: DNU
  Originator clock ID: aaaabbfffebbcccc
  SyncE steps: 2, eSyncE steps: 2
  All steps run eSyncE; Chain of extended ESMC data is complete
Next selection points: ETH_RXMUX
```



CHAPTER 11

Configuring PTP

Table 29: Feature History Table

Feature name	Release Information	Feature Description
Precision Time Protocol (PTP) Support on 88-LC0-36FH-M Line card and 8202-32FH-M Router	Release 7.5.2	With this release, support for Precision Time Protocol (PTP) telecom profiles 8273.2 and 8275.1 is extended to the following: • 88-LC0-36FH-M line card • 8202-32FH-M router Support of PTP profile 8273.2 allows distribution of time and phase synchronization for packet-based network. Support of PTP profile 8275.1 enables network element interoperability for the delivery of accurate phase and time synchronization.
Support for Precision Time Protocol (PTP)	Release 7.3.1	Precision Time Protocol (PTP) is based on the IEEE 1588-2008 clock synchronization standard and enables clocks in a distributed system to be synched with highly precise clocks. The precision in time synchronization is achieved through packets that are transmitted and received in a session between the primary clock and secondary clock. PTP also ensures that the best clock is selected as a timing source (the primary clock) and all other clocks are synchronized with the primary clock.

Precision Time Protocol (PTP) is a protocol that defines a method to distribute time around a network. PTP support is based on the IEEE 1588-2008 standard.

This module describes the concepts around this protocol and details the various configurations involved.

PTP Overview

The Precision Time Protocol (PTP), as defined in the IEEE 1588 standard, synchronizes with nanosecond accuracy the real-time clocks of the devices in a network. The clocks are organized into a master-slave hierarchy. PTP identifies the port that is connected to a device with the most precise clock. This clock is referred to as the master clock. All the other devices on the network synchronize their clocks with the master and are referred to as members. Constantly exchanged timing messages ensure continued synchronization. PTP ensures that the best available clock is selected as the source of time (the grandmaster clock) for the network and that other clocks in the network are synchronized to the grandmaster.

Table 30: PTP Clocks

Network Element	Description
Grandmaster (GM)	A network device physically attached to the primary time source. All clocks are synchronized to the grandmaster clock.
Ordinary Clock (OC)	An ordinary clock is a 1588 clock with a single PTP port that can operate in one of the following modes: • Master mode—Distributes timing information over the network to one or more slave clocks, thus allowing the slave to synchronize its clock to the master. • Slave mode—Synchronizes its clock to a master clock. You can enable the slave mode on up to two interfaces simultaneously in order to connect to two different master clocks.
Boundary Clock (BC)	The device participates in selecting the best master clock and can act as the master clock if no better clocks are detected. Boundary clock starts its own PTP session with a number of downstream slaves. The boundary clock mitigates the number of network hops and packet delay variations in the packet network between the Grand Master and Slave.

Network Element	Description
Transparent Clock (TC)	A transparent clock is a device or a switch that calculates the time it requires to forward traffic and updates the PTP time correction field to account for the delay, making the device transparent in terms of time calculations.

PTP consists of two parts:

- The port State machine and Best Master Clock Algorithm: This provides a method to determine state of the ports in the network that will remain passive (neither master nor slave), run as a master (providing time to other clocks in the network), or run as slaves (receiving time from other clocks in the network).
- Delay-Request/Response mechanism and a Peer-delay mechanism: This provides a mechanisms for slave ports to calculate the difference between the time of their own clocks and the time of their master clock.

Note Transparent Clock (TC) is not supported.

Frequency and Time Selection

The selection of the source to synchronize the device clock frequency is made by frequency synchronization, and is outside of the scope of PTP. The Announce, Sync, and Delay-request frequencies must be the same on the master and slave.

Delay Request-Response Mechanism

The Delay Request-response mechanism (defined in section 11.3 of IEEE Std 1588-2008) lets a slave port estimate the difference between its own clock-time and the clock-time of its master. The following options are supported:

- One-step mechanism - The timestamp for a Sync message is sent in the Sync message itself.
- Two-step mechanism - The timestamp for a Sync message is sent later in a Follow-up message.

When running a port in Slave state, a router can send Delay-request messages and handle incoming Sync, Follow-up, and Delay-response messages. The timeout periods for both Sync and Delay-response messages are individually configurable.

Hybrid Mode

Your router allows the ability to select separate sources for frequency and time-of-day (ToD). Frequency selection can be between any source of frequency available to the router, such as: BITS, GPS, SyncE or IEEE 1588 PTP. The ToD selection is between the source selected for frequency and PTP, if available (ToD selection is from GPS, or PTP). This is known as hybrid mode, where a physical frequency source (BITS or SyncE) is used to provide frequency synchronization, while PTP is used to provide ToD synchronization.

Frequency selection uses the algorithm described in ITU-T recommendation G.781. The ToD selection is controlled using the time-of-day priority configuration. This configuration is found under the clock interface frequency synchronization configuration mode and under the global PTP configuration mode. It controls the

order for which sources are selected for ToD. Values in the range of 1 to 254 are allowed, with lower numbers indicating higher priority.

The steps involved in section *Configuring PTP Hybrid Mode* of the topic G.8275.1, on page 177.

Time of Day (ToD) Support

The router receives GPS ToD messages in serial ASCII stream through the RS422 interface in one of the following configurable formats:

- NTP Type 4
- Cisco

Port States for PTP

State machine indicates the behavior of each port. The possible states are:

State	Description
INIT	Port is not ready to participate in PTP.
LISTENING	First state when a port becomes ready to participate in PTP: In this state, the port listens to PTP masters for a (configurable) period of time.
PRE-MASTER	Port is ready to enter the MASTER state.
MASTER	Port provides timestamps for any Slave or boundary clocks that are listening.
UNCALIBRATED	Port receives timestamps from a Master clock but, the router's clock is not yet synchronized to the Master.
SLAVE	Port receives timestamps from a Master clock and the router's clock is synchronized to the Master.
PASSIVE	Port is aware of a better clock than the one it would advertise if it was in MASTER state and is not a Slave clock to that Master clock.

Restrictions for PTP

The following PTP restrictions apply to the Cisco 8000 Series Router:

- Sync2 interface is supported only if 10 MHz, 1 Pulse per Second (PPS) and time-of-day (ToD) ports are configured.
- PTP is not supported with global MACSec.
- PTP is not supported with MACSec on the same interface.

  However, PTP is supported if MACSec is not configured on interface.
- PTP is not supported with global MACSec-FIPS-Post.

MACSec-FIPS-Post is not available per interface.

- Transparent Clock is not supported. One-step clock is supported. It can receive follow-up PTP packets, that is, it can support a two-step peer primary but it cannot send follow-up PTP packets.
- When a subinterface is configured with encapsulation default or untag configuration, you must configure PTP on that subinterface, instead of the main interface.
- PTP is configurable on Gigabit Ethernet interfaces (1G, 10G, 40G, and 100G), Bundle Ethernet interfaces, and sub-interfaces. PTP is not configurable on LAG Ethernet sub-interfaces.
- PTP is supported over individual bundle member links and not supported on Bundle-Ether interfaces.

PTP Support Information

This table lists different types of support information related to PTP:

Transport Media	• UDP over IPv4 • UDP over IPv6 • Ethernet
Messages	• Signaling • Announce • Sync • Follow-up • Delay-request • Delay-response • Management
Transport Modes	• Unicast: This is the default mode. All packets are sent as unicast messages. Unicast is applicable only for PTP over IP profiles. • Multicast: All packets are sent as multicast messages. Multicast is the only mode for PTP over ethernet profiles.

Timing Profile and Class Support Matrix

This table provides a detailed information on the timing features that are supported on the Cisco 8000 series routers and line cards.

Table 31: Timing Profile and Class Support Matrix

Hardware Module	Supported Profile	Supported G.8273.2 Class	Cisco IOS XR Release
G8273.2	Class B and Class C		
G8273.2	Class B and Class C		
G.8275.2	NA		
• 8000-RP2 Route Processor • 88-LC0-36FH-M and 8800-LC-36FH line cards	G8275.1	NA	Release 7.11.1
	G8273.2	Class C	
• 88-LC0-36FH-M line card • 8202-32FH-M router	G.8273.2	Class C	Release 7.5.2
	G.8275.1	NA	
• 88-LC0-36FH line card • 88-LC0-34H14FH line card • 8201-32FH router	G.8273.2	Class C	Release 7.3.3
	G.8275.1	NA	
• 8201 router • 8202 router • 8800-LC-48H line card • 8800-LC-36FH line card	G.8273.2	Class C	Release 7.3.1
	G.8275.1	NA	
	G.8265.1	NA	
	G.8263	NA	

Configuring PTP Delay Asymmetry

Table 32: Feature History Table

Feature Name	Release Information	Description
PTP Delay Asymmetry	Release 7.3.2	Any delays on Precision Time Protocol (PTP) paths can impact PTP accuracy and in turn impact clock settings for all devices in a network. This feature allows you to configure the static asymmetry such that the delay is accounted for and the PTP synchronization remains accurate. The **delay-symmetry** command is introduced for this feature.

Configure PTP delay asymmetry to offset the static delays on a PTP path that occur due to different route selection for forward and reverse PTP traffic. Delays can also be due to any node having different delay for ingress or egress path. These delays can impact PTP accuracy due to the asymmetry in PTP. With this feature, you can enable a higher degree of accuracy in the PTP server performance leading to better synchronization between real-time clocks of the devices in a network.

Configuration of this delay asymmetry provides an option to configure static delays on a client clock for every server clock. You can configure this delay value in microseconds and nanoseconds. Configured PTP delay asymmetry is also synchronized with the Servo algorithm.

Note

- If you configure multiple PTP delay asymmetries for the same PTP profile, the latest PTP delay asymmetry that you configure is applied to the PTP profile.
- For G8275.1 and G8275.2 PTP profiles, PTP delay asymmetry is supported for both, client port and dynamic port that act as a client.
- Fixed delay can be measured by using any test and measurement tool. Fixed delay can be compensated by using the positive or negative values. For example, if the fixed delay is +10 nanoseconds, configure -10 nanoseconds to compensate the fixed delay.

A positive value indicates that the server-to-client propagation time is longer than the client-to-server propagation time, and conversely for negative values.

Supported PTP Profiles

The following PTP profiles support the configuration of PTP delay asymmetry:

- PTP over IP (G8275.2 or default profile)
- PTP over L2 (G8275.1)

Restrictions

- PTP delay asymmetry can be configured only on the PTP port of the grandmaster clock, which can either be a boundary clock or an ordinary clock.
- PTP delay asymmetry is supported for delay compensation of fixed cables and not for variable delay in the network.
- PTP delay asymmetry can be configured within the range of 3 microseconds and -3 microseconds or 3000 nanoseconds and -3000 nanoseconds.

Configuration

To configure PTP delay asymmetry:

1. Configure an interface with PTP.
2. Configure PTP delay asymmetry on the client side.

Configuration Example

```
/* Configure an interface with PTP. */
Router# configure
Router(config)# interface HundredGigE 0/1/0/0
Router(config-if)# ptp

/* Configure PTP delay asymmetry on the client side. */
Router(config-if-ptp)# delay-asymmetry 3 microseconds
Router(config-if-ptp)# commit
```

Running Configuration

```
interface preconfigure HundredGigE 0/1/0/0
 ptp
  delay-asymmetry 3 microseconds
```

Verification

To verify if PTP delay asymmetry is applied, use the **show ptp foreign-masters** command:

```
Router# show ptp foreign-masters
Sun Nov 1 10:19:21.874 UTC
Interface HundredGigE0/1/0/0 (PTP port number 1)
IPv4, Address 209.165.200.225, Unicast
Configured priority: 1
Configured clock class: None
Configured delay asymmetry: 3 microseconds <- configured variable delay asymmetry value
Announce granted: every 2 seconds, 300 seconds
Sync granted: 16 per-second, 300 seconds
Delay-resp granted: 16 per-second, 300 seconds
Qualified for 2 minutes, 45 seconds
Clock ID: 80e01dfffe8ab73f
Received clock properties:
Domain: 0, Priority1: 128, Priority2: 128, Class: 6
Accuracy: 0x22, Offset scaled log variance: 0xcd70
Steps-removed: 1, Time source: GPS, Timescale: PTP
Frequency-traceable, Time-traceable
Current UTC offset: 37 seconds (valid)
Parent properties:
```

```
Clock ID: 80e01dfffe8ab73f
Port number: 1
```

To validate the approximate compensated delay value, use the **show ptp platform servo** command:

```
Router# show ptp platform servo
Mon Jun 27 22:32:44.912 UTC
Servo status: Running
Servo stat_index: 2
Device status: PHASE_LOCKED
Servo Mode: Hybrid
Servo log level: 0
Phase Alignment Accuracy: -2 ns
Sync timestamp updated: 18838
Sync timestamp discarded: 0
Delay timestamp updated: 18837
Delay timestamp discarded: 0
Previous Received Timestamp T1: 1657002314.031435081  T2: 1657002314.031436686  T3:
1657002314.026815770  T4: 1657002314.026814372
Last Received Timestamp T1: 1657002314.031435081  T2: 1657002314.031436686  T3:
1657002314.088857790  T4: 1657002314.088856392
Offset from master:  0 secs, 1502 nsecs    <<--compensated value shows 1.5 microseconds
because the asymmetry configured under the interface is
3 microseconds.->>
Mean path delay   :  0 secs, 103 nsecs
setTime():0  stepTime():0 adjustFreq():2
Last setTime: 0.000000000 flag:0  Last stepTime:0 Last adjustFreq:-5093
```

ITU-T Telecom Profiles for PTP

Cisco IOS XR software supports ITU-T Telecom Profiles for PTP as defined in the ITU-T recommendations. A profile is a specific selection of PTP configuration options that are selected to meet the requirements of a particular application.

PTP lets you define separate profiles to adapt itself for use in different scenarios. A telecom profile differs in several ways from the default behavior defined in the IEEE 1588-2008 standard and the key differences are mentioned in the subsequent sections.

The following sections describe the ITU-T Telecom Profiles that are supported for PTP.

G.8265.1

G.8265.1 profile fulfills specific frequency-distribution requirements in telecom networks. Features of G.8265.1 profile are:

- Clock advertisement: G.8265.1 profile specifies changes to values used in Announce messages for advertising PTP clocks. The clock class value is used to advertise the quality level of the clock, while the other values are not used.
- Clock Selection: G.8265.1 profile also defines an alternate Best Master Clock Algorithm (BMCA) to select port states and clocks is defined for the profile. This profile also requires to receive Sync messages (and optionally, Delay-Response messages) to qualify a clock for selection.
- Port State Decision: The ports are statically configured to be Master or Slave instead of using state machines to dynamically set port states.
- Packet Rates: The packet rates higher than rates specified in the IEEE 1588-2008 standard are used. They are:

- Sync/Follow-Up Packets: Rates from 128 packets-per-second to 16 seconds-per-packet.
- Delay-Request/Delay-Response Packets: Rates from 128 packets-per-second to 16 seconds-per-packet.
- Announce Packets: Rates from 8 packets-per-second to 64 packets-per-second.

- Transport Mechanism: G.8265.1 profile only supports IPv4 PTP transport mechanism.
- Mode: G.8265.1 profile supports transport of data packets only in unicast mode.
- Clock Type: G.8265.1 profile only supports Ordinary Clock-type (a clock with only one PTP port).
- Domain Numbers: The domain numbers that can be used in a G.8265.1 profile network ranges from 4 to 23.
- Port Numbers: All PTP port numbers can only be one (1) because all clocks in this profile network are Ordinary Clocks.
- G.8261 class-specification standard is supported.

G.8265.1 profile defines an alternate algorithm to select between different master clocks based on the local priority given to each master clock and their quality levels (QL). This profile also defines Packet Timing Signal Fail (PTSF) conditions to identify the master clocks that do not qualify for selection. They are:

- PTSF-lossSync condition: Raised for master clocks that do not receive a reliable stream of Sync and Delay-Resp messages. Cisco IOS XR software requests Sync and Delay-Resp grants for each configured master clock to track the master clock with this condition.
- PTSF-lossAnnounce condition: Raised for master clocks that do not receive a reliable stream of Announce messages.
- PTSF-unusable condition: Raised for master clocks that receives a reliable stream of Announce, Sync, and Delay-Resp messages, but not usable by slave clocks. Cisco IOS XR software does not use this condition.

Configuring Global G.8265.1 Master Profile

The following configuration describes the steps involved to create a global configuration profile for a PTP interface that can then be assigned to any interface as required. It uses G.8265.1 profile as an example:

```
Router# config terminal
Router(config)# ptp
Router(config-ptp)# clock
Router(config-ptp-clock)# domain 4
Router(config-ptp-clock)# profile g.8265.1 clock-type master
Router(config-ptp-clock)# exit
Router(config-ptp)# profile master
Router(config-ptp-profile)# transport ipv4
Router(config-ptp-profile)# sync frequency 32
Router(config-ptp-profile)# announce frequency 1
Router(config-ptp-profile)# delay-request frequency 32
Router(config-ptp-profile)# exit
```

Verification

To display the configured PTP profile details, use **show run ptp** command.

```
Router# show run ptp

Wed Feb 28 11:16:05.943 UTC
ptp
clock domain 4
profile g.8265.1 clock-type master
!
profile master
transport ipv4
sync frequency 32
announce frequency 1
delay-request frequency 32
!
```

Configuring Global G.8265.1 Slave Profile

The following configuration describes the steps involved to create a global configuration profile for a PTP interface that can then be assigned to any interface as required. It uses G.8265.1 profile as an example:

```
Router/# config terminal
Router(config)# ptp
Router(config-ptp)# clock
Router(config-ptp-clock)# domain 4
Router(config-ptp-clock)# profile g.8265.1 clock-type slave
Router(config-ptp-clock)# exit
Router(config-ptp)# profile slave
Router(config-ptp-profile)# transport ipv4
Router(config-ptp-profile)# sync frequency 32
Router(config-ptp-profile)# announce frequency 1
Router(config-ptp-profile)# delay-request frequency 32
Router(config-ptp-profile)# exit
```

Verification

To display the configured PTP profile details, use **show run ptp** command.

```
Router# show run ptp

Wed Feb 28 11:16:05.943 UTC
ptp
clock domain 4
profile g.8265.1 clock-type slave
!
profile slave
transport ipv4
sync frequency 32
announce frequency 1
delay-request frequency 32
!
```

Configuring PTP Master Interface

The following configuration describes the steps involved to configure a PTP interface to be a Master.

```
Router# configure terminal
Router(config)# interface HundredGigE 0/0/0/0
Routerconfig-if)# ipv4 address 18.1.1.1/24
Router(config-if)# ptp
Router(config-if-ptp)# profile master
Router(config-if-ptp)# port state master-only
Router(config-if-ptp)# commit
```

G.8263 Standard

Table 33: Feature History Table

Feature Name	Release Information	Feature Description
Support for ITU-T G.8263 standard for secondary clock with ITU-T G.8265.1 profile	Release 7.3.1	ITU-T G.8263 is a performance compliance standard for secondary clocks configured with ITU-T G.8265.1 profiles. These clocks drive frequency synchronization based on the PTP packets received at the secondary devices, from traceable primary devices.

G.8263 is the performance compliance standard for the clocks with G.8265.1 profile configured. These clocks drive frequency synchronization based on the PTP packets that are received at the secondary devices from traceable primary device. To handle excess PDV in the network, special servo mode is enabled by configuring the **network-type high-pdv** command in the PTP configuration.

Configuration

To configure high PDV mode on the slave clock, use the following steps:

1. Configure telecom profile G.8265.1 and clock-type as slave.
2. Configure network type as high PDV.

Configuration Example

```
/* Configure telecom profile G.8265.1 and clock-type as slave. */
Router# configure
Router(config)# ptp
Router(config-ptp)# clock
Router(config-ptp-clock)# domain 4
Router(config-ptp-clock)# profile g.8265.1 clock-type slave
Router(config-ptp-clock)# commit
Router(config-ptp-clock)# exit

/* Configure network type as high PDV. */
Router(config-ptp)# network-type high-pdv
Router(config-ptp)# commit
```

Running Configuration

```
ptp
 clock
  domain 4
  profile g.8265.1 clock-type slave
 !
 network-type high-pdv
 !
!
```

G.8275.1

Table 34: Feature History Table

Feature Name	Release Information	Feature Description
ITU-T G.8275.1 profile support	Release 7.3.1	This feature supports the architecture defined in ITU-T G.8275 for systems requiring accurate phase and time synchronisation, phase or time-of-day synchronization is required, and where each network device participates in the PTP protocol. Support of this capability is extended on the Cisco 8000 Series router, in this release.

G.8275.1 profile fulfills the time-of-day and phase synchronization requirements in telecom networks with all network devices participating in the PTP protocol. G.8275.1 profile provides better frequency stability for the time-of-day and phase synchronization.

Features of G.8275.1 profile are:

- Synchronization Model: G.8275.1 profile adopts hop-by-hop synchronization model. Each network device in the path from master to slave synchronizes its local clock to upstream devices and provides synchronization to downstream devices.
- Clock Selection: G.8275.1 profile also defines an alternate BMCA that selects a clock for synchronization and port state for the local ports of all devices in the network is defined for the profile. The parameters defined as a part of the BMCA are:
    - Clock Class
    - Clock Accuracy
    - Offset Scaled Log Variance
    - Priority 2
    - Clock Identity
    - Steps Removed
    - Port Identity
    - notSlave flag
    - Local Priority
- Port State Decision: The port states are selected based on the alternate BMCA algorithm. A port is configured to a master-only port state to enforce the port to be a master for multicast transport mode.
- Packet Rates: The nominal packet rate for Announce packets is 8 packets-per-second and 16 packets-per-second for Sync/Follow-Up and Delay-Request/Delay-Response packets.
- Transport Mechanism: G.8275.1 profile only supports Ethernet PTP transport mechanism.

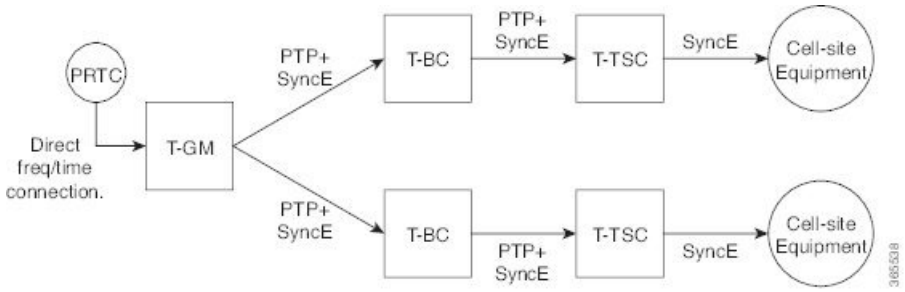
- Mode: G.8275.1 profile supports transport of data packets only in multicast mode. The forwarding is done based on forwardable or non-forwardable multicast MAC address.
- Clock Type: G.8275.1 profile supports the following clock types:
  - Telecom Grandmaster (T-GM): Provides timing for other network devices and does not synchronize its local clock to other network devices.
  - Telecom Time Slave Clock (T-TSC): A slave clock synchronizes its local clock to another PTP clock, but does not provide PTP synchronization to any other network devices.
  - Telecom Boundary Clock (T-BC): Synchronizes its local clock to a T-GM or an upstream T-BC clock and provides timing information to downstream T-BC or T-TSC clocks.
- Domain Numbers: The domain numbers that can be used in a G.8275.1 profile network ranges from 24 to 43. The default domain number is 24.

The G.8275.1 supports the following:

- T-GM: The telecom grandmaster (T-GM) provides timing to all other devices on the network. It does not synchronize its local clock with any other network element other than the Primary Reference Time Clock (PRTC).
- T-BC: The telecom boundary clock (T-BC) synchronizes its local clock to a T-GM or an upstream T-BC, and provides timing information to downstream T-BCs or T-TSCs. If at a given point in time there are no higher-quality clocks available to a T-BC to synchronize to, it may act as a grandmaster.
- T-TSC: The telecom time slave clock (T-TSC) synchronizes its local clock to another PTP clock (in most cases, the T-BC), and does not provide synchronization through PTP to any other device.

The following figure describes a sample G.8275.1 topology.

Figure 6: A Sample G.8275.1 Topology



Configuring Global G.8275.1 Profile

The following configuration describes the steps involved to create a global PTP configuration profile that can be applied at an interface level. It uses G.8275.1 profile as an example:

```
Router# config terminal
Router(config)# ptp
Router(config-ptp)# clock
Router(config-ptp-clock)# domain 24
Router(config-ptp-clock)# profile g.8275.1 clock-type T-BC
Router(config-ptp-clock)# exit
Router(config-ptp)# profile slave
```

```
Router(config-ptp-profile)# multicast target-address ethernet 01-1B-19-00-00-00
Router(config-ptp-profile)# transport ethernet
Router(config-ptp-profile)# sync frequency 16
Router(config-ptp-profile)# announce frequency 8
Router(config-ptp-profile)# delay-request frequency 16
Router(config-ptp-profile)# exit
Router(config-ptp)# profile master
Router(config-ptp-profile)# multicast target-address ethernet 01-1B-19-00-00-00
Router(config-ptp-profile)# transport ethernet
Router(config-ptp-profile)# sync frequency 16
Router(config-ptp-profile)# announce frequency 8
Router(config-ptp-profile)# delay-request frequency 16
Router(config-ptp-profile)# exit
Router(config-ptp)# physical-layer-frequency
Router(config-ptp)# log
Router(config-ptp-log)# servo events
Router(config-ptp-log)# commit
```

Verification

To display the configured PTP profile details, use **show run ptp** command.

```
Router# show run ptp

Wed Feb 28 11:16:05.943 UTC
ptp
 clock
  domain 24
  profile g.8275.1 clock-type T-BC
 !
 profile slave
  multicast target-address ethernet 01-1B-19-00-00-00
  transport ethernet
  sync frequency 16
  announce frequency 8
  delay-request frequency 16
 !
 profile master
  multicast target-address ethernet 01-1B-19-00-00-00
  transport ethernet
  sync frequency 16
  announce frequency 8
  delay-request frequency 16
 !
 physical-layer-frequency
 log
  servo events
!
```

Configuring PTP Master Interface

The below configuration describes the steps involved to configure a PTP interface to be a Master.

```
Router# configure terminal
Router(config)# interface HundredGigE0/0/0/0
Router(config-if)# ptp
Router(config-if-ptp)# profile master
Router(config-if-ptp)# port state master-only
Router(config-if-ptp)# commit
```

Verification

To verify the port state details, use **show run interface** *interface-name* command.

```
Router# show run interface HundredGigE0/0/0/0
interface HundredGigE0/0/0/0
 ptp
  profile master
  port state master-only
!
```

Configuring PTP Slave Interface

This procedure describes the steps involved to configure a PTP interface to be a Slave.

```
Router# configure terminal
Router(config)# interface HundredGigE0/0/0/1
Router(config-if)# ptp
Router(config-if-ptp)# profile slave
Router(config-if-ptp)# port state slave-only
Router(config-if-ptp)# commit
```

Verification

To verify the port state details, use **show run interface** *interface-name* command.

```
Router# show run interface HundredGigE0/0/0/1
interface HundredGigE0/0/0/1
 ptp
  profile slave
  port state slave-only
 !
!
```

Configuring PTP Hybrid Mode

This procedure describes the steps involved to configure router in a hybrid mode. You configure hybrid mode by selecting PTP for phase and time-of-day (ToD) and another source for the frequency.

Note

- G.8275.1 PTP profile supports only the hybrid mode. It is mandatory to have hybrid mode for G8275.1 profile for T-BC and T-TSC clock types. By default, the hybrid mode is used, regardless of the physical-layer-frequency configuration.

To configure PTP Hybrid mode:

1. Configure Global Frequency Synchronization

   ```
   Router(config)# frequency synchronization
   Router(config)# commit
   ```

2. Configure Frequency Synchronization for an Interface. The time-of-day-priority setting specifies that SyncE to be used as a ToD source if there is no source available with a lower priority.

   ```
   Router(config)# interface HundredGigE 0/0/0/0
   Router(config-if)# frequency synchronization
   Router(config-if-freqsync)# selection input
   Router(config-if-freqsync)# time-of-day-priority 100
   Router(config-if-freqsync)# commit
   ```

Verification

```
Router # show frequency synchronization selection location 0/RP0/CP$

Tue Feb  6 06:34:17.627 UTC
Node 0/RP0/CPU0:
==============
Selection point: T0-SEL-B (3 inputs, 1 selected)
Last programmed 00:01:04 ago, and selection made 00:00:24 ago
Next selection points
SPA scoped : None
Node scoped : CHASSIS-TOD-SEL
Chassis scoped: LC_TX_SELECT
Router scoped : None
Uses frequency selection
Used for local line interface output
S Input Last Selection Point QL Pri Status
== ======================== ======================== ===== === ===========
1 HundredGigE 0/0/0/0 0/2/CPU0 ETH_RXMUX 1 ePRTC 1 Locked
PTP [0/RP0/CPU0] n/a PRS 254 Available
Internal0 [0/RP0/CPU0] n/a ST3E 255 Available

Selection point: T4-SEL (3 inputs, 1 selected)
Last programmed 00:01:04 ago, and selection made 00:00:24 ago
Next selection points
SPA scoped : None
Node scoped : None
Chassis scoped: None
Router scoped : None
Uses frequency selection
Used for local clock interface output
S Input Last Selection Point QL Pri Status
== ======================== ======================== ===== === ===========
1 HundredGigE 0/0/0/0 0/2/CPU0 ETH_RXMUX 1 ePRTC 1 Locked
PTP [0/RP0/CPU0] n/a PRS 254 Available
Internal0 [0/RP0/CPU0] n/a ST3E 255 Available

Selection point: 1588-SEL (2 inputs, 1 selected)
Last programmed 00:01:04 ago, and selection made 00:00:24 ago
Next selection points
SPA scoped : None
Node scoped : None
Chassis scoped: None
Router scoped : None
Uses frequency selection
S Input Last Selection Point QL Pri Status
== ======================== ======================== ===== === ===========
1 HundredGigE 0/0/0/0 0/2/CPU0 ETH_RXMUX 1 ePRTC 1 Locked
Internal0 [0/RP0/CPU0] n/a ST3E 255 Available

Selection point: CHASSIS-TOD-SEL (2 inputs, 1 selected)
Last programmed 00:00:53 ago, and selection made 00:00:51 ago
Next selection points
SPA scoped : None
Node scoped : None
Chassis scoped: None
Router scoped : None
Uses time-of-day selection
S Input Last Selection Point Pri Time Status
== ======================== ======================== === ==== ===========
1 PTP [0/RP0/CPU0] n/a 100 Yes Available
HundredGigE 0/0/0/0 0/RP0/CPU0 T0-SEL-B 1 100 No Available

RP/0/RP0/CPU0:SF-D#
```

```
RP/0/RP0/CPU0:SF-D#
RP/0/RP0/CPU0:SF-D#show frequency synchronization selection location 0/RP0/CP$
Thu Jan 1 00:16:56.105 UTC
Node 0/RP0/CPU0:
==============
Selection point: T0-SEL-B (3 inputs, 1 selected)
Last programmed 00:01:09 ago, and selection made 00:00:29 ago
Next selection points
SPA scoped : None
Node scoped : CHASSIS-TOD-SEL
Chassis scoped: LC_TX_SELECT
Router scoped : None
Uses frequency selection
Used for local line interface output
S Input Last Selection Point QL Pri Status
== ======================== ======================== ===== === ===========
1 HundredGigE 0/0/0/0 0/2/CPU0 ETH_RXMUX 1 ePRTC 1 Locked
PTP [0/RP0/CPU0] n/a PRS 254 Available
Internal0 [0/RP0/CPU0] n/a ST3E 255 Available

Selection point: T4-SEL (3 inputs, 1 selected)
Last programmed 00:01:09 ago, and selection made 00:00:29 ago
Next selection points
SPA scoped : None
Node scoped : None
Chassis scoped: None
Router scoped : None
Uses frequency selection
Used for local clock interface output
S Input Last Selection Point QL Pri Status
== ======================== ======================== ===== === ===========
1 HundredGigE 0/0/0/0 0/2/CPU0 ETH_RXMUX 1 ePRTC 1 Locked
PTP [0/RP0/CPU0] n/a PRS 254 Available
Internal0 [0/RP0/CPU0] n/a ST3E 255 Available

Selection point: 1588-SEL (2 inputs, 1 selected)
Last programmed 00:01:09 ago, and selection made 00:00:29 ago
Next selection points
SPA scoped : None
Node scoped : None
Chassis scoped: None
Router scoped : None
Uses frequency selection
S Input Last Selection Point QL Pri Status
== ======================== ======================== ===== === ===========
1 HundredGigE 0/0/0/0 0/2/CPU0 ETH_RXMUX 1 ePRTC 1 Locked
Internal0 [0/RP0/CPU0] n/a ST3E 255 Available

Selection point: CHASSIS-TOD-SEL (2 inputs, 1 selected)
Last programmed 00:00:57 ago, and selection made 00:00:56 ago
Next selection points
SPA scoped : None
Node scoped : None
Chassis scoped: None
Router scoped : None
Uses time-of-day selection
S Input Last Selection Point Pri Time Status
== ======================== ======================== === ==== ===========
1 PTP [0/RP0/CPU0] n/a 100 Yes Available
HundredGigE 0/0/0/0 0/RP0/CPU0 T0-SEL-B 1 100 No Available
```

ITU-T Telecom Profile Examples:

G.8265.1 Profile Configuration Examples

Master Global Configuration:

```
frequency synchronization
 quality itu-t option 1
 log selection changes
!
ptp
 clock
 domain 4
 profile g.8265.1 clock-type master
 !
  profile master
  transport ipv4
  sync frequency 64
  announce frequency 1
  delay-request frequency 64
 interface HundredGigE 0/2/0/4
  ptp
   profile master
   port state master-only
  !
 ipv4 address 18.1.1.1 255.255.255.0
!
```

Note For G.8265.1 PTP master clock, either SyncE or BITS reference source configuration is recommended. Otherwise, the device uses its own internal clock.

Slave Global Configuration:

```
frequency synchronization
 quality itu-t option 1
 log selection changes
!
ptp
 clock
 domain 4
 profile g.8265.1 clock-type slave
 !
  profile slave
  transport ipv4
  sync frequency 64
  announce interval 1
  delay-request frequency 64
interface HundredGigE 0/1/0/0
 ptp
  profile slave
  Master ipv4 18.1.1.1
  port state slave-only
  !
 ipv4 address 18.1.1.2/24
```

G.8275.1 Profile Configuration Examples

Master Global Configuration:

```
frequency synchronization
 quality itu-t option 1
 log selection changes
!
ptp
 clock
 domain 24
 profile g.8275.1 clock-type T-GM
 !
  profile master
  transport ethernet
  sync frequency 16
  announce frequency 8
  delay-request frequency 16
interface HundredGigE 0/2/0/4
 ptp
  profile master
  multicast target-address ethernet 01-1B-19-00-00-00
  !
 ipv4 address 17.1.1.1/24
```

Note For T-GM clocks, sync2 clock interface has to be configured and it should be UP.

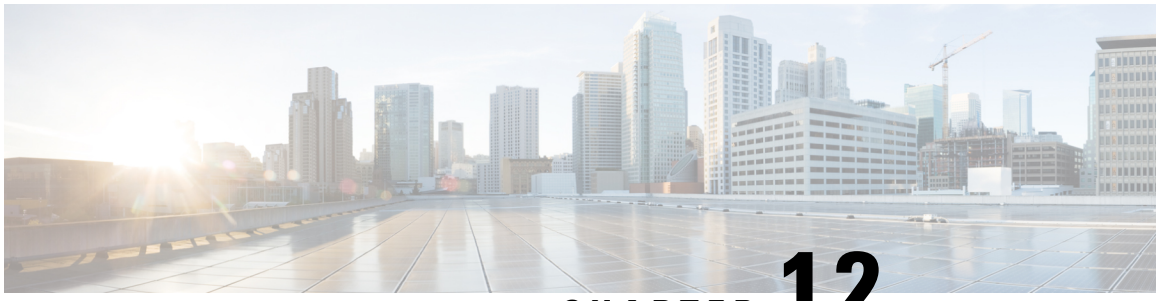
Configuring With Clock Type as Slave Clock (T-TSC):

```
frequency synchronization
 quality itu-t option 1
 log selection changes
!
ptp
 clock
 domain 24
 physical layer frequency
 profile g.8275.1 clock-type T-TSC
 !
  profile slave
  transport ethernet
  sync frequency 16
  announce frequency 8
  delay-request frequency 16
interface HundredGigE 0/1/0/0
 ptp
  profile slave
  multicast target-address ethernet 01-1B-19-00-00-00
  !
 ipv4 address 18.1.1.2/24
```

Configuring With Clock Type as Boundary Clock (T-BC)

```
frequency synchronization
 quality itu-t option 1
 log selection changes
!
ptp
```

```
 clock
 domain 24
 physical layer frequency
 profile g.8275.1 clock-type T-BC
 !
  profile master
  transport ethernet
  sync frequency 16
  announce frequency 8
  delay-request frequency 16
  exit
  profile slave
  transport ethernet
  sync frequency 16
  announce frequency 8
  delay-request frequency 16
  exit
interface HundredGigE 0/2/0/4
 frequency synchronization
 selection input
 priority 2
 wait-to-restore 0
 ptp
  profile slave
  multicast target-address ethernet 01-1B-19-00-00-00
  !
 ipv4 address 17.1.1.2/24
interface HundredGigE 0/2/0/0
 ptp
  profile master
  multicast target-address ethernet 01-1B-19-00-00-0
  !
 ipv4 address 18.1.1.1/24
```



CHAPTER 12

The Network Configuration Protocol

The Network Configuration Protocol (Netconf) provides mechanisms to install, manipulate, and delete the configuration of network devices. It uses an Extensible Markup Language (XML)-based data encoding for the configuration data as well as the protocol messages, as defined in RFC6241. Yang is a data modeling language used with Netconf, as defined in RFC6020.

Netconf uses a simple RPC-based (Remote Procedure Call) mechanism to facilitate communication between a client and a server. The client can be a script or application typically running as part of a network manager. The server is typically a network device.

Netconf runs within a Secure Shell (SSH) session as an SSH subsystem, as defined in RFC6242.

The configuration of features need not be done the traditional way (using CLIs), the client application (controller) reads the Yang model and communicates with the Netconf server (IOS XR) accordingly.

Netconf Sessions and Operations

A Netconf session is the logical connection between a network configuration application and a network device. A device should be capable of supporting multiple sessions and atleast one Netconf session.

Characteristics of a netconf session:

- Netconf is connection-oriented - SSH is the underlying transport.
- The netconf client establishes session with the server.
- Netconf sessions are established with the *hello* message. Features and capabilities are announced.
- Sessions can be terminated using the *close* or *kill* messages.

Basic Netconf operations:

- Get configuration <get-config>
- Get all information <get>

- Edit configuration <edit-config>
- Copy configuration <copy-config>

Note <copy-config> does not support source attribute with “data store” at present.

- <lock>, <unlock>
- <kill-session>
- <close-session>
- Commit configuration <commit>

The Yang data model

Each feature has a defined Yang Model which is synthesized from the schemas. A model is published in a tree format and includes:

- Top level nodes and their subtrees
- Subtrees that augment nodes in other yang models

```
Example: The aaa Yang model
(exec-19.42.10) bash-4.2$ pyang -f tree Cisco-IOS-XR-aaa-lib-cfg.yang
module: Cisco-IOS-XR-aaa-lib-cfg
    +--rw aaa
       +--rw accountings
       |  +--rw accounting* [type listname]
       |     +--rw type                  xr:Cisco-ios-xr-string
       |     +--rw listname              xr:Cisco-ios-xr-string
       |     +--rw rp-failover?          dt1:Aaa-accounting-rp-failover
       |     +--rw broadcast?            dt1:Aaa-accounting-broadcast
       |     +--rw type-xr?              dt1:Aaa-accounting
       |     +--rw method1?              dt1:Aaa-method-accounting
       |     +--rw method2?              dt1:Aaa-method-accounting
       |     +--rw method3?              dt1:Aaa-method-accounting
       |     +--rw method4?              dt1:Aaa-method-accounting
       |     +--rw server-group-name1?   string
       |     +--rw server-group-name2?   string
       |     +--rw server-group-name3?   string
       |     +--rw server-group-name4?   string
       +--rw authorizations
       |  +--rw authorization* [type listname]
       |     +--rw type                  xr:Cisco-ios-xr-string
       |     +--rw listname              xr:Cisco-ios-xr-string
       |     +--rw method1?              dt1:Aaa-method
       |     +--rw method2?              dt1:Aaa-method
       |     +--rw method3?              dt1:Aaa-method
       |     +--rw method4?              dt1:Aaa-method
       |     +--rw server-group-name1?   string
       |     +--rw server-group-name2?   string
       |     +--rw server-group-name3?   string
       |     +--rw server-group-name4?   string
       +--rw accounting-update!
       |  +--rw type                 dt1:Aaa-accounting-update
       |  +--rw periodic-interval?   uint32
```

```
+--rw banner
|  +--rw login?   string
+--rw authentications
   +--rw authentication* [type listname]
      +--rw type                  xr:Cisco-ios-xr-string
      +--rw listname              xr:Cisco-ios-xr-string
      +--rw method1?              dt1:Aaa-method
      +--rw method2?              dt1:Aaa-method
      +--rw method3?              dt1:Aaa-method
      +--rw method4?              dt1:Aaa-method
      +--rw server-group-name1?   string
      +--rw server-group-name2?   string
      +--rw server-group-name3?   string
      +--rw server-group-name4?   string
```

Advantages of using the Yang model are:

- Yang supports programmatic interfaces.
- Yang supports simplified network management applications.
- Yang supports interoperability that provides a standard way to model management data.

Netconf and Yang

The workflow displayed here, will help the user to understand how Netconf-Yang can configure and control the network with minimal user intervention. The required components:

- Cisco 8000 Series Router with Netconf capability
- Netconf Client Application with connection to the router

S. No.	Device / component	Action
1	Cisco router	Login/ access the router.
2	Cisco router	Prerequisites for enabling Netconf: • Crypto keys must be generated.
3	Cisco router	Enable Netconf agent. Use the **netconf-yang agent ssh** and **ssh server netconf** command. The port can be selected. By default, it is set as 830.
4	Cisco router	Yang models are a part of the software image. The models can be retrieved from the router , using the <get-schema> operation.

S. No.	Device / component	Action
5	Netconf client (application) The application can be on any standalone application or a SDN controller supporting Netconf	Installs and processes the Yang models. The client can offer a list of supported yang models; else the user will have to browse and locate the required yang file. There is a yang model file for each configuration module; for instance if the user wants to configure CDP , the relevant yang model is Cisco-IOS-XR-cdp-cfg **Note** Refer the table which lists all the supported yang models Supported Yang Models , on page 190
5	Netconf client	Sends Netconf operation request over SSH to the router. A configuration request could include Yang-based XML data to the router. Currently, SSH is the only supported transport method.
6	Cisco router	Understands the Yang-based XML data and the network is configured accordingly (in case of configuration request from the client).
		The interactions between the client and the router happens until the network is configured as desired.

Supported Yang Models

The Yang models can be downloaded from a prescribed location (ftp server) or can also be retrieved directly from the router using the get-schema operation.

For a feature, separate Yang models are available for configuring the feature and to get operational statistics (show commands). The **-cfg.yang** suffix denotes configuration and **-oper*.yang** is for operational data statistics. In some cases, **-oper** is followed by **-sub**, indicating that a submodule(s) is available.

For a list of supported Yang models, see https://github.com/YangModels/yang/tree/master/vendor/cisco/xr

Denial of Services Defense for Netconf-Yang

In case of a DoS (Denial of Service) attack on Netconf, wherein, Netconf receives numerous requests in a short span of time, the router may become irresponsive if Netconf consumes most of the bandwidth or CPU processing time. This can be prevented, by limiting the traffic directed at the Netconf agent. This is achieved using the **netconf-yang agent rate-limit** and **netconf-yang agent session** commands.

If rate-limit is set, the Netconf processor measures the incoming traffic from the SSH server. If the incoming traffic exceeds the set rate-limit, the packets are dropped.

If session-limit is set, the Netconf processor checks for the number of open sessions. If the number of current sessions is greater than or equal to, the set limit, no new sessions are opened.

Session idle- timeout and absolute-timeout also prevent DoS attacks. The Netconf processor closes the sessions, even without user input or intervention, as soon at the time out session is greater than or equal to the set time limit.

The relevant commands are discussed in detail, in the *System Security Command Reference for Cisco 8000 Series Routers*

Enabling NETCONF over SSH

This task enables NETCONF over SSH. SSH is currently the only supported transport method .

If the client supports, Netconf over ssh can utilize the multi-channeling capabilities of IOS XR ssh server.

Prerequisite:

- Crypto keys must be generated prior to this configuration.

Step 1 **configure**

Example:

```
RP/0/RP0/CPU0:router# configure
```

Enters mode.

Step 2 **netconf-yang agent ssh**

Example:

```
RP/0/RP0/CPU0:router (config) # netconf agent ssh
```

Enables NETCONF agent over SSH connection. After NETCONF is enabled, the Yang model in the controllcker, can configure the relevant models.

Note The Yang models can be retrieved from the router via NETCONF <get-schema> operation.

Step 3 **ssh server netconf** [**vrf** *vrf-name* [**ipv4 access-list***ipv4 access list name*] [**ipv6 access-list** *ipv6 access list name*]]

Example:

```
RP/0/RP0/CPU0:router (config) # ssh server netconf vrf netconfvrf ipv4 access-list InternetFilter
```

Brings up the netconf subsytem support with SSH server using a specified VRF of up to 32 characters. If no VRF is specified, the default VRF is used. To stop the SSH server from receiving any further connections for the specified VRF, use the **no** form of this command.

Optionally ACLs for IPv4 and IPv6 can be used to restrict access to the netconf subsystem of the ssh server before the port is opened.

Note The netconf subsystem support with SSH server can be configured for use with multiple VRFs .

Step 4 **ssh server netconf port** *port-number*

Example:

```
RP/0/RP0/CPU0:router (config) # ssh server netconf port 830
```

Configures a port for the netconf ssh server. This command is optional. If no port is specified, port 830 is uses by default.

Note 830 is the IANA-assigned TCP port for NETCONF over SSH, but it can be changed using this command.

What to do next

The **show netconf-yang statistics** command and **show netconf-yang clients** command can be used to verify the configuration details of the netconf agent.

The **clear netconf-yang agent session** command clears the specified Netconf session (on the Netconf server side).

Examples: Netconf over SSH

This section illustrates some examples relevant to Netconf:

Enabling netconf-yang for ssh transport and netconf subsystem for default vrf with default port (830)

```
config
netconf-yang agent ssh
ssh server netconf vrf default
  !
!
```

Enabling netconf-yang for ssh transport and netconf subsystem for vrf *green* and vrf *red* with netconf port (831)

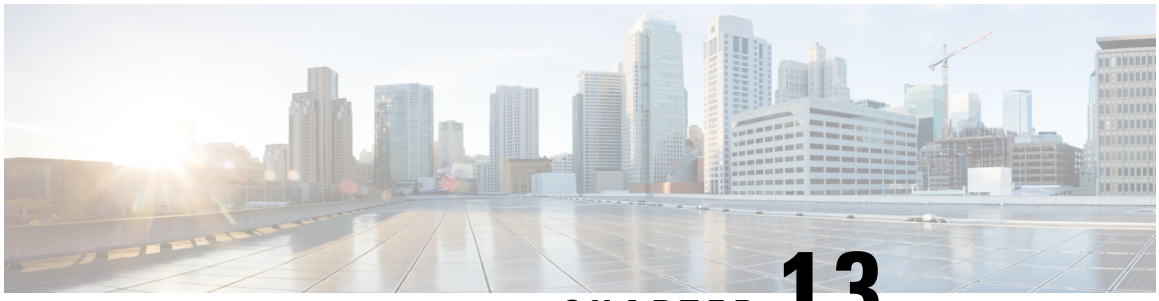
```
config
netconf-yang agent ssh
!
ssh server netconf vrf green
ssh server netconf vrf red
ssh server netconf port 831
  !
!
```

Show command outputs

```
show netconf-yang statistics
Summary statistics        requests|             total time|   min time per request|   max
time per request|   avg time per request|
other                              0|       0h  0m  0s   0ms|       0h  0m  0s   0ms|
 0h  0m  0s   0ms|       0h  0m  0s   0ms|
close-session                      4|       0h  0m  0s   3ms|       0h  0m  0s   0ms|
 0h  0m  0s   1ms|       0h  0m  0s   0ms|
kill-session                       0|       0h  0m  0s   0ms|       0h  0m  0s   0ms|
 0h  0m  0s   0ms|       0h  0m  0s   0ms|
get-schema                         0|       0h  0m  0s   0ms|       0h  0m  0s   0ms|
 0h  0m  0s   0ms|       0h  0m  0s   0ms|
get                                0|       0h  0m  0s   0ms|       0h  0m  0s   0ms|
 0h  0m  0s   0ms|       0h  0m  0s
get-config                         1|       0h  0m  0s   1ms|       0h  0m  0s   1ms|
 0h  0m  0s   1ms|       0h  0m  0s   1ms|
edit-config                        3|       0h  0m  0s   2ms|       0h  0m  0s   0ms|
 0h  0m  0s   1ms|       0h  0m  0s   0ms|
commit                             0|       0h  0m  0s   0ms|       0h  0m  0s   0ms|
 0h  0m  0s   0ms|       0h  0m  0s   0ms|
cancel-commit                      0|       0h  0m  0s   0ms|       0h  0m  0s   0ms|
 0h  0m  0s   0ms|       0h  0m  0s   0ms|
```

```
lock                                0|       0h  0m  0s   0ms|       0h  0m  0s   0ms|
 0h  0m  0s   0ms|       0h  0m  0s   0ms|
unlock                              0|       0h  0m  0s   0ms|       0h  0m  0s   0ms|
 0h  0m  0s   0ms|       0h  0m  0s   0ms|
discard-changes                     0|       0h  0m  0s   0ms|       0h  0m  0s   0ms|
 0h  0m  0s   0ms|       0h  0m  0s   0ms|
validate                            0|       0h  0m  0s   0ms|       0h  0m  0s   0ms|
 0h  0m  0s   0ms|       0h  0m  0s   0ms|

show netconf-yang clients
client session ID|   NC version|    client connect time|        last OP time|        last
OP type|    <lock>|
22969|                 1.1|         0d  0h  0m  2s|             11:11:24|
close-session|        No|
15389|                1.1|        0d  0h  0m  1s|            11:11:25|         get-config|
          No|
```



CHAPTER 13

Configuration and File System Management

This module describes methods for configuration management and file transfer enhancements.

Secure file transfer from the Router

Table 35: Feature History Table

Feature Name	Release Information	Feature Description
Secure file transfer from the Router	Release 7.9.1	Your routers are now enabled to transfer files securely to an archive server. It's made possible because the copy command now supports SFTP (Secure File Transfer Protocol) and SCP (Secure Copy Protocol using the underlying SSH protocol implementation. Secure transfer of files from the router maintains the integrity, confidentiality, and availability of network configurations. This feature modifies the **copy** command.

You can duplicate files or data in the router from one location to another using the **copy** command. This functionality helps to create a copy of a file, folder, or data set and place it in a specific destination. You can use the copy functionality to back up files, move data between directories, create duplicates of the files for editing or distribution without modifying the original content. It also allows you to retain the original data while making a duplicate that you can further manipulate independently.

Starting with Cisco IOS XR Release 7.9.1, we've enhanced the functionality of the copy command to support secure file transfer from the router. Secure file transfer protects data during transit using the SFTP (Secure File Transfer Protocol) and SCP (Secure Copy Protocol) when sharing files within or across networks. The

SFTP and SCP functionalities in the copy feature use the SSH protocol implementation in the router to secure transfer the files to a remote server.

You can use the following options in the **copy** command for secure file transfer:

- **sftp:** You can transfer the files to a remote location using the **SFTP** file transfer protocol. SFTP is a secure file transfer protocol for transferring large files.
- **scp:** You can transfer the files to a remote location using the **SCP** file transfer protocol. SCP is a secure copy protocol to transfer files between servers.

Starting Cisco IOS XR Software Release 7.10.1, you can use public-key authentication while copying the running configuration.

Configuration Example for SCP and SFTP Using Public-Key Authentication

While you're using public-key authentication for copying running configuration from the router to a remote server, you don't need to mention **password** in the command. The following example shows how you can configure public-key authentication while copying configuration using the SCP protocol:

```
Router#copy running-config scp://root@192.0.4.2//var/opt/run_conf_scp.txt
```

Prerequisites for secure file transfer

Enable the SSH Server in the router:

```
Router# config
Router(config)# ssh server v2
Router(config)# ssh server vrf default
Router(config)# ssh server netconf vrf default
Router(config)# commit
```

Secure file transfer using SFTP

You can copy the running configuration file from the router to a remote server using SFTP as follows:

```
Router# copy running-config sftp://root:testpassword@192.0.2.1//var/opt/run_conf_sftp.txt

Destination file name (control-c to cancel): [/var/opt/run_conf_sftp.txt]?

.
215 lines built in 1 second
[OK]Connecting to 192.0.2.1...22
Password:
sftp> put /tmp/tmpsymlink/nvgen-34606-_proc_34606_fd_75 /var/opt/run_conf_sftp.txt


/tmp/tmpsymlink/nvgen-34606-_proc_34606_fd_75

  Transferred 3271 Bytes
  3271 bytes copied in 0 sec (3271000)bytes/sec
sftp> exit
```

Verification in the SFTP Server

```
[root@sftp_server ~]# ls -ltr /var/opt/run_conf_sftp.txt
-rw-r--r-- 1 root root 3271 Mar 21 18:07 /var/opt/run_conf_sftp.txt
```

Secure file transfer using SCP

You can copy the running configuration file from the router to a remote server using SFTP as follows:

```
Router# copy running-config sftp://root:testpassword@192.0.2.1//var/opt/run_conf_sftp.txt

Destination file name (control-c to cancel): [/var/opt/run_conf_sftp.txt]?

.
215 lines built in 1 second
[OK]Connecting to 192.0.2.1...22
Password:
sftp> put /tmp/tmpsymlink/nvgen-34606-_proc_34606_fd_75 /var/opt/run_conf_sftp.txt


/tmp/tmpsymlink/nvgen-34606-_proc_34606_fd_75

  Transferred 3271 Bytes
  3271 bytes copied in 0 sec (3271000)bytes/sec
sftp> exit
```

Verification in the SFTP Server

```
[root@sftp_server ~]# ls -ltr /var/opt/run_conf_sftp.txt
-rw-r--r-- 1 root root 3271 Mar 21 18:07 /var/opt/run_conf_sftp.txt
```

Auto-Save Configuration

Table 36: Feature History Table

Feature Name	Release Information	Feature Description
Auto-Save with Secure File-Transfer and Additional Configurable Parameters	Release 7.9.1	Apart from automatically backing up the running configuration after every commit, you can also do the following with Auto-Save: • Save running configurations to remote systems using Secure Copy Protocol (SCP) and Secure File Transfer Protocol (SFTP). • Configure wait-time between two subsequent auto-saves. • Append time-stamp to the file name of the saved configuration. • Save the encrypted password. • Specify the maximum number of files that you can auto-save. The feature introduces these changes: CLI: Modified the **configuration commit auto-save**command by adding the following keywords: • **filename scp** • **filename sftp** • **wait-time** • **timestamp** • **password** • **maximum** Yang Data Model: • New XPaths for Cisco-IOS-XR-config-autosave-cfg • New XPaths for Cisco-IOS-XR-um-config-commit-cfg

You can configure the router to automatically take the backup of the running configuration by using **configuration commit auto-save** command. This auto-save feature saves the configuration to the specified location on the router after every **commit** is made. These auto-save files are stored in the form of Linux files.

Starting Cisco IOS XR Software Release 7.9.1, the auto-save feature is enhanced to provide a set of functionalities. Use the following keywords to achieve the same:

- **scp and sftp** - You can save the running configuration backup files to remote location using **scp** and **sftp** file transfer protocols. SCP is a secure copy protocol to transfer files between servers. Whereas SFTP is a secure file transfer protocol for transfering large files.
- **password** - You can can save encrypted passwords for the remote and non-remote URLs.
- **maximum** - You can mention maximum number of files that can be saved automatically. Once the maximum number of auto-saved file is reached, the newer auto-save files starts replacing the older auto-save files. The default value of **maximum** is 1. You can save upto 4294967295 files.
- **timestamp** - Using this keyword, the time-stamp can be appended to the auto-saved configuration file name. The **timestamp** uses the time and timezone configured on the router. The saved file displays timestamp in <day> <month> <date> <hours> <minutes> <seconds> <milliseconds> format. Here is an example of auto-saved file with time-stamp - *: test_123.autosave.1.ts.Tue_Jan_31_15-15-51_805_IST*
- **wait-time** - You can specify how long to wait before next auto-save happens in terms of days, months or hours after the commit is made. The default value of **wait-time** is zero.

Restriction for Auto-Save Configuration

The auto-save configuration is only available on the local paths, scp, and sftp paths.

Starting Cisco IOS XR Software Release 7.10.1, you can use public-key authentication while automatically saving the running configuration. For more detailed information on how to use public-key authentication, see Auto-Save and Copy Router Configuration Using Public Key Authentication, on page 200.

Configure Auto-Save

Use the **configuration commit auto-save** command to auto save the configuration.

```
Router#configure
Router(config)#configuration commit auto-save
Router(config-cfg-autosave)#commit
```

You can also configure options such as **password**, **timestamp**, **maximum**, and **wait-time** with the **configuration commit auto-save** command. The location to save the file-name must be specified in <protocol>://<user>@<host>:<port>/<url-path>/<file-name> format.

```
Router(config-cfg-autosave)#configuration commit auto-save filename
sftp://user1@server1://test-folder/test_123
Router(config-cfg-autosave)#password clear encryption-default cisco
Router(config-cfg-autosave)#timestamp
Router(config-cfg-autosave)#maximum 10
Router(config-cfg-autosave)#wait-time days 0 hours 0 minutes 0 seconds 5
Router(config-cfg-autosave)#commit
```

Running Configuration

```
Router#show running-config configuration commit auto-save
configuration commit auto-save
 filename sftp://user1@server1://test-folder/test_123
 password encrypted encryption-default <password for above user>
 timestamp
 maximum 10
 wait-time days 0 hours 0 minutes 0 seconds 5
!
```

Auto-Save and Copy Router Configuration Using Public Key Authentication

Table 37: Feature History Table

Feature Name	Release Information	Feature Description
Auto-Save and Copy Router Configuration Using Public Key Authentication	Release 7.10.1	You can now experience passwordless authentication while automatically saving running configurations and securely copying them on the router. The feature uses public key-based authentication, a secure logging method using a secure shell (SSH), which provides increased data security. This feature offers automatic authentication and single sign-on benefits, which also aids in a secure automation process. The feature introduces these changes: **CLI:** • The **configuration commit auto-save** command supports password-less authentication. • The **copy** command supports password-less authentication.

From Cisco IOS XR Software Release 7.10.1, you don't need to remember and enter the **password** as you can use public key-based authentication while doing the following:

- Automatically saving your running configuration
- Copying the configuration from a source (such as a network server) to a destination (such as a flash disk)

Password is automatically verified when you have enabled SSH connection using public key-based authentication. Using public key-based authentication avoids several problems such as password disclosure and password leakage.

Public key is mathematically related to private key. The private key is secret, whereas the public key is available on the servers. You can copy the public key to the SSH server from the SSH client. Then, when you try to secure the running configuration, the SSH server tries to authenticate by generating a challenge using the public key. Only the private key can answer this challenge. As the keys are related, log-in is successful.

Prerequisites for Auto-Save and Copy Router Configuration Using Public Key Authentication

Ensure you have enabled public key-based authentication of SSH clients, using the following steps:

- Generate RSA key pair on the router configured as the SSH client. Use the **cyrpto key generate authentication-ssh rsa** command to generate the RSA key pair.
- Use the **show crypto key mypubkey authentication-ssh rsa** command to view the details of the RSA key. The key value starts with *ssh-rsa* in this output.
- Copy the RSA public key from the SSH client to the SSH server.

For more detailed information on how to enable SSH connection using public-key based authentication, see *Public Key Based Authentication of SSH Clients* in System Security Configuration Guide for Cisco 8000 Series Routers.

Configuration Example for Auto-Save Using Public Key Authentication

When you are using public key authentication, you don't need to mention **password**.

```
Router(config-cfg-autosave)#configuration commit auto-save filename
sftp://user1@server1://test-folder/test_123
Router(config-cfg-autosave)#timestamp
Router(config-cfg-autosave)#maximum 10
Router(config-cfg-autosave)#wait-time days 0 hours 0 minutes 0 seconds 5
Router(config-cfg-autosave)#commit
```

Running Configuration

```
Router#show running-config configuration commit auto-save
configuration commit auto-save
 filename sftp://user1@server1://test-folder/test_123
 timestamp
 maximum 10
 wait-time days 0 hours 0 minutes 0 seconds 5
!
```