



System Management Configuration Guide for Cisco NCS 5500 Series Routers, IOS XR Release 7.9.x

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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 xiii](#)
- [Communications, Services, and Additional Information, on page xiii](#)

Changes to this Document

Table 1: Changes to this Document

Date	Summary
March 2023	Initial release of this document

Communications, Services, and Additional Information

- To receive timely, relevant information from Cisco, sign up at [Cisco Profile Manager](#).
- To get the business impact you're looking for with the technologies that matter, visit [Cisco Services](#).
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Cisco Bug Search Tool

[Cisco Bug Search Tool](#) (BST) is a web-based tool that acts as a gateway to the Cisco bug tracking system that maintains a comprehensive list of defects and vulnerabilities in Cisco products and software. BST provides you with detailed defect information about your products and software.



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 7.9.x, on page 1](#)

System Management Features Added or Modified in IOS XR Release 7.9.x

Feature	Description	Changed in Release	Where Documented
FQDN for NTP Server on Non-default VRF	This feature was introduced	Release 7.9.1	FQDN for NTP Server, on page 139
Support for SFTP (Secure File Transfer Protocol) and SCP (Secure Copy Protocol) options in the Copy command	This feature was introduced.	Release 7.9.1	Secure file transfer from the Router, on page 293



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, on page 3](#)

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 XPath. 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 Manageability

This module describes the configuration required to enable the Extensible Markup Language (XML) agent services. The XML Parser Infrastructure provides parsing and generation of XML documents with Document Object Model (DOM), Simple Application Programming Interface (API) for XML (SAX), and Document Type Definition (DTD) validation capabilities:

- DOM allows customers to programmatically create, manipulate, and generate XML documents.
- SAX supports user-defined functions for XML tags.
- DTD allows for validation of defined document types.
- [Information about XML Manageability, on page 5](#)
- [How to Configure Manageability, on page 5](#)
- [Configuration Examples for Manageability, on page 6](#)

Information about XML Manageability

The Cisco IOS XR Extensible Markup Language (XML) API provides a programmable interface to the router for use by external management applications. This interface provides a mechanism for router configuration and monitoring utilizing XML formatted request and response streams. The XML interface is built on top of the Management Data API (MDA), which provides a mechanism for Cisco IOS XR components to publish their data models through MDA schema definition files.

Cisco IOS XR software provides the ability to access the router via XML using a dedicated TCP connection, Secure Socket Layer (SSL), or a specific VPN routing and forwarding (VRF) instance.

How to Configure Manageability

Configuring the XML Agent

This explains how to configure the XML agent.

SUMMARY STEPS

1. **xml agent** [ssl]
2. **iteration on size** *iteration-size*
3. **session timeout** *timeout*

4. `throttle {memory size | process-rate tags}`
5. `vrf {vrfname | default} [ipv4 access-list access-list-name]`

DETAILED STEPS

	Command or Action	Purpose
Step 1	xml agent [ssl] Example: RP/0/RP0/CPU0:router(config)# xml agent ssl	Enables Extensible Markup Language (XML) requests over a dedicated TCP connection and enters XML agent configuration mode. Use the ssl keyword to enable XML requests over Secure Socket Layer (SSL).
Step 2	iteration on size <i>iteration-size</i> Example: RP/0/RP0/CPU0:router(config-xml-agent)# iteration on size 500	Configures the iteration size for large XML agent responses in KBytes. The default is 48.
Step 3	session timeout <i>timeout</i> Example: RP/0/RP0/CPU0:router(config-xml-agent)# session timeout 5	Configures an idle timeout for the XML agent in minutes. By default, there is no timeout.
Step 4	throttle {memory size process-rate tags} Example: RP/0/RP0/CPU0:router(config-xml-agent)# throttle memory 300	Configures the XML agent processing capabilities. <ul style="list-style-type: none"> • Specify the memory size in Mbytes. Values can range from 100 to 600. In IOS XR 64 bit, the values range from 100 to 1024. The default is 300. • Specify the process-rate as the number of tags that the XML agent can process per second. Values can range from 1000 to 30000. By default the process rate is throttled.
Step 5	vrf {vrfname default} [ipv4 access-list access-list-name] Example: RP/0/RP0/CPU0:router(config-xml-agent)# vrf vrf1	Configures the dedicated agent or SSL agent to receive and send messages via the specified VPN routing and forwarding (VRF) instance.

Configuration Examples for Manageability

Enabling VRF on an XML Agent: Examples

The following example illustrates how to configure the dedicated XML agent to receive and send messages via VRF1, VRF2 and the default VRF:

```
RP/0/RP0/CPU0:router(config)# xml agent
RP/0/RP0/CPU0:router(config-xml-agent)# vrf VRF1
RP/0/RP0/CPU0:router(config-xml-agent)# vrf VRF2
```

The following example illustrates how to remove access to VRF2 from the dedicated agent:

```
RP/0/RP0/CPU0:router(config)# xml agent ssl  
RP/0/RP0/CPU0:router(config-xml-ssl)# vrf VRF1  
RP/0/RP0/CPU0:router(config-xml-ssl-vrf)# vrf VRF2  
  
RP/0/RP0/CPU0:router(config)# xml agent  
RP/0/RP0/CPU0:router(config-xml-agent)# no vrf VRF1
```

The following example shows how to configure the XML SSL agent to receive and send messages through VRF1, VRF2 and the default VRF:

```
RP/0/RP0/CPU0:router(config)# xml agent ssl  
RP/0/RP0/CPU0:router(config-xml-agent)# vrf VRF1  
RP/0/RP0/CPU0:router(config-xml-agent)# vrf VRF2
```

The following example removes access for VRF2 from the dedicated XML agent:

```
RP/0/RP0/CPU0:router(config)# xml agent ssl  
RP/0/RP0/CPU0:router(config-xml-agent)# no vrf VRF2
```




CHAPTER 4

Configuring Physical and Virtual Terminals

Line templates define standard attribute settings for incoming and outgoing transport over physical and virtual terminal lines (vty). 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, on page 9](#)
- [Information About Implementing Physical and Virtual Terminals, on page 9](#)
- [How to Implement Physical and Virtual Terminals on Cisco IOS XR Software, on page 12](#)
- [Configuration Examples for Implementing Physical and Virtual Terminals, on page 16](#)

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 NCS 5500 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.



Note Before creating or modifying the vty pools, enable the telnet server using the **telnet server** command in XR Config mode. See Cisco IOS XR IP Addresses and Services Configuration Guide and Cisco IOS XR IP Addresses and Services Command Reference 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 global configuration 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. <ul style="list-style-type: none"> • 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: <ul style="list-style-type: none"> • end • commit Example: RP/0/RP0/CPU0:router(config-line)# end	Saves configuration changes. <ul style="list-style-type: none"> • When you issue the end command, the system prompts you to commit changes: <pre>Uncommitted changes found, commit them before exiting(yes/no/cancel)? [cancel]:</pre>

	Command or Action	Purpose
	or <pre>RP/0/RP0/CPU0:router(config-line)# commit</pre>	<ul style="list-style-type: none"> • 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.

You can omit Step 3 to Step 5 (**line template** and **exit** commands) if you are configuring the default line template to reference a vty pool.

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. **vti-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: <pre>RP/0/RP0/CPU0:router# configure</pre>	Enters global configuration mode.
Step 2	telnet {ipv4 ipv6} server max-servers limit Example: <pre>RP/0/RP0/CPU0:router(config)# telnet ipv4 server max-servers 10</pre>	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 <i>template-name</i> 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 <i>pool-name</i> eem } <i>first-vty last-vty</i> [line-template { default <i>template-name</i> }] 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 RP/0/RP0/CPU0:router(config)#vty-pool default 0 5 line-template template1	Creates or modifies vty pools. <ul style="list-style-type: none"> 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. <ul style="list-style-type: none"> 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. <i>pool-name</i> —Creates a user-defined vty pool. <ul style="list-style-type: none"> 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. <ul style="list-style-type: none"> The default embedded event manager vty pool must start at vty 100 and must contain a minimum of six vtys (vtys 100 through 105). line-template <i>template-name</i> —Configures the vty pool to reference a user-defined template.

	Command or Action	Purpose
Step 7	Use the commit or end command.	<p>commit —Saves the configuration changes and remains within the configuration session.</p> <p>end —Prompts user to take one of these actions:</p> <ul style="list-style-type: none"> • 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	<p>(Optional) show line [aux location <i>node-id</i> console location <i>node-id</i> vty number]</p> <p>Example:</p> <pre>RP/0/RP0/CPU0:router# show line</pre>	<p>Displays the terminal parameters of terminal lines.</p> <ul style="list-style-type: none"> • Specifying the show line aux location <i>node-id</i> EXEC command displays the terminal parameters of the auxiliary line. • Specifying the show line console location <i>node-id</i> EXEC command displays the terminal parameters of the console. <ul style="list-style-type: none"> • For the location <i>node-id</i> keyword and argument, enter the location of the Route Processor (RP) on which the respective auxiliary or console port resides. • The <i>node-id</i> argument is expressed in the format of <i>rack/slot/module</i> .

	Command or Action	Purpose
		<ul style="list-style-type: none"> Specifying the <code>show line vty number EXEC</code> command displays the terminal parameters for the specified vty.
Step 2	(Optional) show terminal Example: <pre>RP/0/RP0/CPU0:router# show terminal</pre>	Displays the terminal attribute settings for the current terminal line.
Step 3	(Optional) show users Example: <pre>RP/0/RP0/CPU0:router# show users</pre>	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:

```
RP/0/RP0/CPU0:router# show running-config line console
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:router# show line console location 0/0/CPU0
Tue Nov 24 03:10:24.656 UTC
Tty          Speed      Overruns      Acc I/O
*con0/0/CPU0  9600      0/0           -/-

Line "con0_RP1_CPU0", Location "0/RP1/CPU0", Type "Console"
Length: 24 lines, Width: 80 columns
Baud rate (TX/RX) is 9600, "No" Parity, 2 stopbits, 8 databits
Template: console
Capabilities: Timestamp Enabled
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 100 105 line-template test3
```




CHAPTER 5

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, on page 19](#)
- [Restrictions for SNMP use on Cisco IOS XR Software, on page 19](#)
- [Information about Implementing SNMP, on page 20](#)
- [Session MIB support on subscriber sessions , on page 26](#)
- [How to Implement SNMP on Cisco IOS XR Software, on page 28](#)
- [SNMP Context Mapping Configuration, on page 47](#)

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 A 10 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





Note A few exceptions while performing SNMP walk on the NC55-6X200-DWDM-S line card on the NCS 5500 Series Routers are as follows:

1. Though the below mentioned OIDs are valid, they are marked as inaccessible in the OTN MIB standard. Hence they will not be polled during MIB walk.
 - OtnNearEndCurIntervalType : .1.3.6.1.4.1.9.9.639.1.2.3.1.1
 - OtnNearEndCurrentMonType : .1.3.6.1.4.1.9.9.639.1.2.3.1.2
 - OtnFarEndCurIntervalType : .1.3.6.1.4.1.9.9.639.1.2.4.1.1
 - OtnFarEndCurrentMonType : .1.3.6.1.4.1.9.9.639.1.2.4.1.2
2. OtnStatus : .1.3.6.1.4.1.9.9.639.1.1.1.1.5 OID is implicitly enabled for the interfaces of NC55-6X200-DWDM-S line card. Hence a MIB walk corresponding to the OtnStatus is not supported.

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.

From Release 6.3.2 onwards, 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 from Release 6.3.2 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 23](#) 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

Feature	SNMP v1	SNMP v2c	SNMP v3
Inform Operation	No	Yes (No on the Cisco IOS XR software)	Yes (No on the Cisco IOS XR software)
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.

Model	Level	Authentication	Encryption	What Happens
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 (k9sec) 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

Security Model	Security Level
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.

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

Table 5: Feature History Table

Feature Name	Release Information	Feature Description
Delay timer for SNMP Traps	Release 7.4.1	This enhancement allows configuration of SNMP trap notifications to be sent after 30 minutes and within 240 minutes after reload of the router.

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.



Note After reload of the router, the SNMP traps can be configured to be sent with a minimum duration of 30 minutes and maximum duration of 240 minutes after the reload.

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

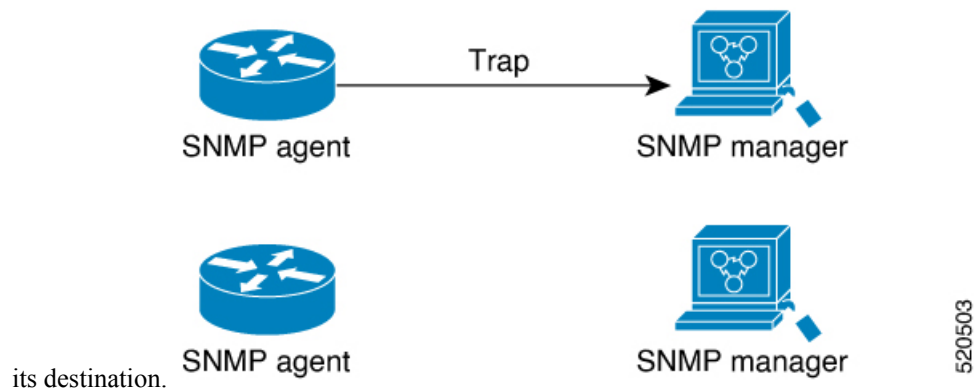
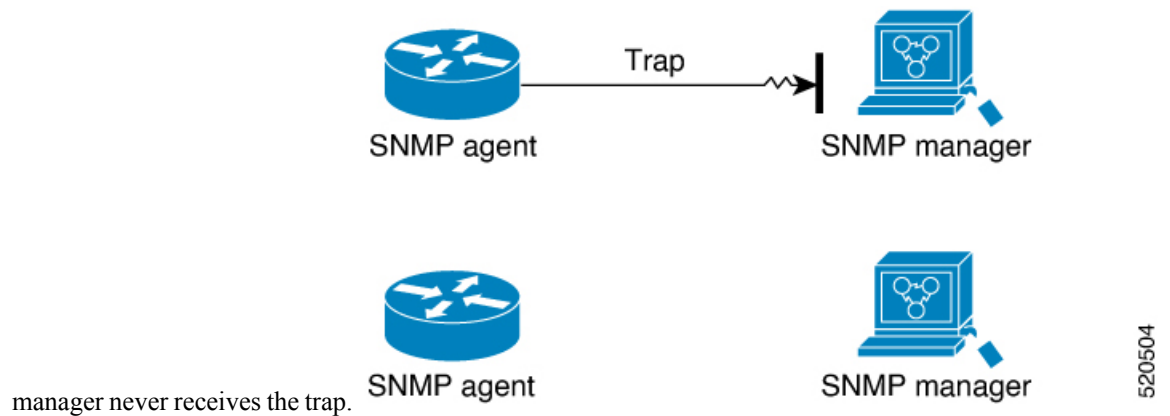


Figure 3: Trap Not Received by the SNMP Manager

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



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 NCS 5500 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.

SUMMARY STEPS

1. **configure**
2. (Optional) **snmp-server engineid local engine-id**
3. (Optional) **snmp-server vrf vrf-name**
4. **snmp-server view view-name oid-tree {included | excluded}**
5. **snmp-server group name {v1 | v2c | v3 {auth | noauth | priv}} [read view] [write view] [notify view] [access-list-name]**
6. **snmp-server user username groupname {v1 | v2c | v3 [auth {md5 | sha} {clear | encrypted} auth-password [priv des56 {clear | encrypted} priv-password]]} [access-list-name]**
7. Use the **commit** or **end** command.
8. (Optional) **show snmp**
9. (Optional) **show snmp engineid**
10. (Optional) **show snmp group**
11. (Optional) **show snmp users**
12. (Optional) **show snmp view**

DETAILED STEPS

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

	Command or Action	Purpose
Step 2	(Optional) snmp-server engineid local <i>engine-id</i> Example: <pre>RP/0/RP0/CPU0:router(config)# snmp-server engineID local 00:00:00:09:00:00:00:a1:61:6c:20:61</pre>	Specifies the identification number of the local SNMP engine.
Step 3	(Optional) snmp-server vrf <i>vrf-name</i> Example: <pre>RP/0/RP0/CPU0:router(config)# snmp-server vrf vrfname</pre>	Configures VRF properties of SNMP.
Step 4	snmp-server view <i>view-name oid-tree</i> { included excluded } Example: <pre>RP/0/RP0/CPU0:router(config)# snmp-server view view_name 1.3.6.1.2.1.1.5 included</pre>	Creates or modifies a view record.
Step 5	snmp-server group <i>name</i> { v1 v2c v3 { auth noauth priv }} [read view] [write view] [notify view] [<i>access-list-name</i>] Example: <pre>RP/0/RP0/CPU0:router(config)# snmp-server group group_name v3 noauth read view_name1 write view_name2</pre>	Configures a new SNMP group or a table that maps SNMP users to SNMP views.
Step 6	snmp-server user <i>username groupname</i> { v1 v2c v3 [auth { md5 sha } { clear encrypted } <i>auth-password</i> [priv des56 { clear encrypted } <i>priv-password</i>]}] [<i>access-list-name</i>] Example: <pre>RP/0/RP0/CPU0:router(config)# snmp-server user noauthuser group_name v3</pre>	Configures a new user to an SNMP group.
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: <ul style="list-style-type: none"> • 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.

	Command or Action	Purpose
Step 8	(Optional) show snmp Example: RP/0/RP0/CPU0:router# show snmp	Displays information about the status of SNMP.
Step 9	(Optional) show snmp engineid Example: RP/0/RP0/CPU0:router# show snmp engineid	Displays information about the local SNMP engine.
Step 10	(Optional) show snmp group Example: RP/0/RP0/CPU0:router# show snmp group	Displays information about each SNMP group on the network.
Step 11	(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 12	(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.

SUMMARY STEPS

1. **configure**
2. **snmp-server drop unknown-user**
3. Use the **commit** or **end** command.

DETAILED STEPS

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

	Command or Action	Purpose
Step 2	snmp-server drop unknown-user Example: <pre>RP/0/RP0/CPU0:router(config)# snmp-server drop unknown-user</pre>	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: <ul style="list-style-type: none"> • 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:

```
config
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:

```
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: vldefault
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 Because 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: localSnmID
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 Because 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

This task explains how to configure the router to send SNMP trap notifications.



Note You can omit `#unique_55` if you have already completed the steps documented under the `#unique_55` task.

SUMMARY STEPS

1. **configure**
2. **snmp-server group** *name* {**v1 v2 v3** {**auth** | **noauth** | **priv**}} [**read view**] **write view**] [**notify view**] [*access-list-name*]
3. **snmp-server user** *username groupname* {**v1 v2c v3** {**auth** | **md5** | **sha**} {**clear** | **encrypted**} *auth-password*] [**priv des56** {**clear** | *access-list-name*}]
4. [**snmp-server host** *address* [**traps**] [**version** {**1** | **2c** | **3** [**auth** | **priv**}]}] *community-string* [**udp-port port**] [*notification-type*]
5. **snmp-server traps** [*notification-type*]
6. Use the **commit** or **end** command.
7. (Optional) **show snmp host**

DETAILED STEPS

	Command or Action	Purpose
Step 1	configure Example: RP/0/RP0/CPU0:router# configure	Enters global configuration mode.
Step 2	snmp-server group <i>name</i> { v1 v2 v3 { auth noauth priv }} [read view] write view] [notify view] [<i>access-list-name</i>] Example: RP/0/RP0/CPU0:router(config)# 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-server user <i>username groupname</i> { v1 v2c v3 { auth md5 sha } { clear encrypted } <i>auth-password</i>] [priv des56 { clear <i>access-list-name</i> }] Example:	Configures a new SNMP group or a table that maps SNMP users to SNMP views.

	Command or Action	Purpose
	RP/0/RP0/CPU0:router(config)# snmp-server group group_name v3 noauth read view_name1 writer view_name2	
Step 4	[snmp-server host <i>address</i> [traps] [version { 1 2c 3 [auth priv }]] <i>community-string</i> [udp-port <i>port</i>] [<i>notification-type</i>] 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 5	snmp-server traps [<i>notification-type</i>] 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. <ul style="list-style-type: none"> • If a trap is not specified with the <i>notification-type</i> 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 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: <ul style="list-style-type: none"> • 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 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.

SUMMARY STEPS

1. **configure**
2. **snmp-server drop unknown-user**

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

DETAILED STEPS

	Command or Action	Purpose
Step 1	<p>configure</p> <p>Example:</p> <pre>RP/0/RP0/CPU0:router# configure</pre>	Enters global configuration mode.
Step 2	<p>snmp-server drop unknown-user</p> <p>Example:</p> <pre>RP/0/RP0/CPU0:router(config)# snmp-server drop unknown-user</pre>	Drop the error PDUs when the router is polled with incorrect SNMPv3 user name.
Step 3	Use the commit or end command.	<p>commit —Saves the configuration changes and remains within the configuration session.</p> <p>end —Prompts user to take one of these actions:</p> <ul style="list-style-type: none"> • 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 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
!
```

In the following example, the output of the **show snmp host** command 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

```
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.

SUMMARY STEPS

1. **configure**
2. (Optional) **snmp-server contact** *system-contact-string*
3. (Optional) **snmp-server location** *system-location*
4. (Optional) **snmp-server chassis-id** *serial-number*
5. Use the **commit** or **end** command.

DETAILED STEPS

	Command or Action	Purpose
Step 1	configure Example: RP/0/RP0/CPU0:router# configure	Enters global configuration mode.
Step 2	(Optional) snmp-server contact <i>system-contact-string</i> 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 <i>system-location</i> 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 <i>serial-number</i> 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: <ul style="list-style-type: none"> • 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.

SUMMARY STEPS

1. **configure**
2. (Optional) **snmp-server packetsize** *byte-count*
3. Use the **commit** or **end** command.

DETAILED STEPS

	Command or Action	Purpose
Step 1	configure Example: RP/0/RP0/CPU0:router# <code>configure</code>	Enters global configuration mode.
Step 2	(Optional) snmp-server packetsize <i>byte-count</i> Example: RP/0/RP0/CPU0:router(config)# <code>snmp-server packetsize 1024</code>	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: <ul style="list-style-type: none"> • 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.

SUMMARY STEPS

1. **configure**
2. (Optional) **snmp-server trap-source** *type interface-path-id*
3. (Optional) **snmp-server queue-length** *length*

4. (Optional) **snmp-server trap-timeout** *seconds*
5. Use the **commit** or **end** command.

DETAILED STEPS

	Command or Action	Purpose
Step 1	configure Example: RP/0/RP0/CPU0:router# configure	Enters global configuration mode.
Step 2	(Optional) snmp-server trap-source <i>type interface-path-id</i> 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 <i>length</i> 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 <i>seconds</i> 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: <ul style="list-style-type: none"> • 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 IP Precedence or IP DSCP for SNMP traffic.

Before you begin

SNMP must be configured.

SUMMARY STEPS

1. **configure**
2. Use one of the following commands:
 - **snmp-server ipv4 precedence** *value*
 - **snmp-server ipv4 dscp** *value*
3. Use the **commit** or **end** command.

DETAILED STEPS

	Command or Action	Purpose
Step 1	configure Example: RP/0/RP0/CPU0:router# configure	Enters global configuration mode.
Step 2	Use one of the following commands: <ul style="list-style-type: none"> • snmp-server ipv4 precedence <i>value</i> • snmp-server ipv4 dscp <i>value</i> Example: RP/0/RP0/CPU0:router(config)# snmp-server dscp 24	Configures an IP precedence or IP 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: <ul style="list-style-type: none"> • 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 IP Precedence value to 7:

```
configure
 snmp-server ipv4 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 IP 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
```

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.

SUMMARY STEPS

1. `show snmp context-mapping`

DETAILED STEPS

	Command or Action	Purpose
Step 1	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.

SUMMARY STEPS

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

DETAILED STEPS

	Command or Action	Purpose
Step 1	<p>snmp-server mibs eventmib packet-loss type interface-path-id falling lower-threshold interval sampling-interval rising upper-threshold</p> <p>Example:</p> <pre>RP/0/RP0/CPU0:router(config)# snmp-server mibs eventmib packet-loss falling 1 interval 5 rising 2</pre>	<p>Generates SNMP EVENT-MIB traps for the interface when the packet loss exceeds the specified thresholds. Up to 100 interfaces can be monitored.</p> <p>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.</p> <p>interval sampling-interval —Specifies how often packet loss statistics are polled. This is a value between 5 and 1440 minutes, in multiples of 5.</p> <p>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.</p>

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.

SUMMARY STEPS

1. (Optional) **snmp-server entityindex persist**
2. (Optional) **snmp-server mibs cbqosmib persist**

3. (Optional) `snmp-server cbqosmib cache refresh time time`
4. (Optional) `snmp-server cbqosmib cache service-policy count count`
5. `snmp-server ifindex persist`

DETAILED STEPS

	Command or Action	Purpose
Step 1	(Optional) <code>snmp-server entityindex persist</code> Example: <code>RP/0/RP0/CPU0:router(config)# snmp-server entityindex persist</code>	Enables the persistent storage of ENTITY-MIB data.
Step 2	(Optional) <code>snmp-server mibs cbqosmib persist</code> Example: <code>RP/0/RP0/CPU0:router(config)# snmp-server mibs cbqosmib persist</code>	Enables persistent storage of the CISCO-CLASS-BASED-QOS-MIB data.
Step 3	(Optional) <code>snmp-server cbqosmib cache refresh time <i>time</i></code> Example: <code>RP/0/RP0/CPU0:router(config)# snmp-server mibs cbqosmib cache refresh time 45</code>	Enables QoS MIB caching with a specified cache refresh time.
Step 4	(Optional) <code>snmp-server cbqosmib cache service-policy count <i>count</i></code> Example: <code>RP/0/RP0/CPU0:router(config)# snmp-server mibs cbqosmib cache service-policy count 50</code>	Enables QoS MIB caching with a limited number of service policies to cache.
Step 5	<code>snmp-server ifindex persist</code> Example: <code>RP/0/RP0/CPU0:router(config)# snmp-server ifindex persist</code>	Enables ifIndex 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.

SUMMARY STEPS

1. **configure**
2. **snmp-server interface subset** *subset-number* **regular-expression** *expression*
3. **notification linkupdown disable**
4. Use the **commit** or **end** command.
5. (Optional) **show snmp interface notification subset** *subset-number*
6. (Optional) **show snmp interface notification regular-expression** *expression*
7. (Optional) **show snmp interface notification** *type interface-path-id*

DETAILED STEPS

	Command or Action	Purpose
Step 1	configure Example: <pre>RP/0/RP0/CPU0:router# configure</pre>	Enters global configuration mode.
Step 2	snmp-server interface subset <i>subset-number</i> regular-expression <i>expression</i> Example: <pre>RP/0/RP0/CPU0:router(config)# snmp-server interface subset 10 regular-expression "^Gig[a-zA-Z]+[0-9/]+\."</pre> <pre>RP/0/RP0/CPU0:router(config-snmp-if-subset)#</pre>	<p>Enters snmp-server interface mode for the interfaces identified by the regular expression.</p> <p>The <i>subset-number</i> 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.</p> <p>The <i>expression</i> argument must be entered surrounded by double quotes.</p> <p>Refer to the <i>Understanding Regular Expressions, Special Characters, and Patterns</i> module in for more information regarding regular expressions.</p>
Step 3	notification linkupdown disable Example: <pre>RP/0/RP0/CPU0:router(config-snmp-if-subset)# notification linkupdown disable</pre>	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.	<p>commit —Saves the configuration changes, and remains within the configuration session.</p> <p>end —Prompts user to take one of these actions:</p> <ul style="list-style-type: none"> • 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.

	Command or Action	Purpose
Step 5	(Optional) show snmp interface notification subset <i>subset-number</i> 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 <i>expression</i> 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 <i>interface-path-id</i> 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.

SNMP Context Mapping Configuration

Configuration of VRF Aware SNMP Context for Polling BGP Data

VRF awareness is usually done using existing, non-VRF aware MIB definitions. This means that MIB definition doesn't mention anything about VRFs. However they could be used within VRF context.

The VRF-awareness is done using SNMP contexts, where a SNMP context maps to a specific VRF.

Before you begin

- Ensure that MIB implementation is VRF-aware.
- Ensure that the implementation of all get requests support VRF context.

The following example configures VRF aware SNMP context to allow polling BGP data using BGP4-MIB.

```
snmp-server vrf <vrf_1> context <context_1>
snmp-server community <vrf_1> RW
snmp-server context <context_1>
snmp-server community-map <vrf_1> context <context_1>
snmp-server host <IP> traps version 2c <vrf_1>
```

Verification

The following configuration extracts BGP data from a peer VRF using context.

```
snmp-server vrf V1
  context V1_bgp
!
snmp-server community V1 RW
```

```

snmp-server context V1_bgp
snmp-server community-map V1 context V1_bgp
router bgp 65000
  nsr
  address-family ipv4 unicast
  !
  address-family vpv4 unicast
  !
  neighbor 192.0.2.254
    remote-as 65001
    address-family ipv4 unicast
      route-policy ALL in
      route-policy ALL out
    !
  !
vrf V1
  rd 111:111
  address-family ipv4 unicast
  !
  neighbor 192.0.2.255
    remote-as 65003
    address-family ipv4 unicast
  !
  !
!
!
end

```

Configuration of OSPF processes Using SNMP Context

The following example configures data polling from two OSPF processes.

```

snmp-server community com1 RW
snmp-server community com2 RW
snmp-server context ctx1
snmp-server context ctx2
snmp-server community-map com1 context ctx1
snmp-server community-map com2 context ctx2
router ospf one
  snmp context ctx1
  area 0
    interface GigabitEthernet0/2/0/0
    !
  !
!
router ospf two
  snmp context ctx2
  area 0
    interface GigabitEthernet0/2/0/1
    !
  !
!

```

Configuration of OSPF Neighbour in VRF

The following example configures OSPF neighbours in VRF using SNMP context.

```

snmp-server vrf VRF_A
  context ctx1
  !
snmp-server community com1 RW
snmp-server context ctx1
snmp-server community-map com1 context ctx1
router ospf core

```

```
vrf VRF_A
  snmp context ctx1
!
!
end
```




CHAPTER 6

Configuring Object Tracking

This module describes the configuration of object tracking on your Cisco IOS XR network. For complete descriptions of the commands listed in this module, see **Additional References** section. To locate documentation for other commands that might appear in the course of performing a configuration task, see **Technical Documentation** section in the Additional References topic.

- [Configuring Object Tracking, on page 51](#)
- [Prerequisites for Implementing Object Tracking, on page 51](#)
- [Information about Object Tracking, on page 52](#)
- [How to Implement Object Tracking, on page 52](#)
- [Configuration Examples for Configuring Object Tracking, on page 63](#)
- [Additional References, on page 65](#)

Configuring Object Tracking

This module describes the configuration of object tracking on your Cisco IOS XR network. For complete descriptions of the commands listed in this module, see **Additional References** section. To locate documentation for other commands that might appear in the course of performing a configuration task, see **Technical Documentation** section in the Additional References topic.

Prerequisites for Implementing Object Tracking

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.



Note Object Tracking is an optional package. You must check if this package is installed on your system by running the command **show install active summary**.

Information about Object Tracking

Object tracking is a mechanism to track an object and to take an action on another object with no relationship to the tracked objects, based on changes to the properties of the object being tracked.

Each tracked object is identified by a unique name specified on the tracking command-line interface (CLI). Cisco IOS XR processes then use this name to track a specific object.

The tracking process periodically polls the tracked object and reports any changes to its state in terms of its being up or down, either immediately or after a delay, as configured by the user.

Multiple objects can also be tracked by means of a list, using a flexible method for combining objects with Boolean logic. This functionality includes:

- **Boolean AND function**—When a tracked list has been assigned a Boolean AND function, each object defined within a subset must be in an up state, so that the tracked object can also be in the up state.
- **Boolean OR function**—When the tracked list has been assigned a Boolean OR function, it means that at least one object defined within a subset must also be in an up state, so that the tracked object can also be in the up state.

How to Implement Object Tracking

This section describes the various object tracking procedures.

Tracking the Line Protocol State of an Interface

Perform this task in global configuration mode to track the line protocol state of an interface.

A tracked object is considered up when a line protocol of the interface is up.

After configuring the tracked object, you may associate the interface whose state should be tracked and specify the number of seconds to wait before the tracking object polls the interface for its state.

SUMMARY STEPS

1. **configure**
2. **track** *track-name*
3. **type line-protocol state**
4. **interface** *type interface-path-id*
5. **exit**
6. (Optional) **delay** {**up** *seconds* | **down** *seconds*}
7. 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 global configuration mode.
Step 2	track track-name Example: RP/0/RP0/CPU0:router(config)# track track1	Enters track configuration mode. • <i>track-name</i> —Specifies a name for the object to be tracked. Note Special characters are not allowed in a <i>track-name</i> .
Step 3	type line-protocol state Example: RP/0/RP0/CPU0:router(config-track)# type line-protocol state	Creates a track based on the line protocol of an interface.
Step 4	interface type interface-path-id Example: RP/0/RP0/CPU0:router(config-track-line-prot)# interface atm 0/2/0/0.1	Specifies the interface to track the protocol state. • <i>type</i> —Specifies the interface type. For more information, use the question mark (?) online help function. • <i>interface-path-id</i> —Identifies a physical interface or a virtual interface. Note Use the show interfaces command to see a list of all possible interfaces currently configured on the router. Note The loopback and null interfaces are always in the up state and, therefore, cannot be tracked.
Step 5	exit Example: RP/0/RP0/CPU0:router(config-track-line-prot)# exit	Exits the track line protocol configuration mode.
Step 6	(Optional) delay {up seconds down seconds} Example: RP/0/RP0/CPU0:router(config-track)# delay up 10	Schedules the delay that can occur between tracking whether the object is up or down.
Step 7	Use one of the following commands:	Saves configuration changes.

	Command or Action	Purpose
	<ul style="list-style-type: none"> • end • commit <p>Example:</p> <pre>RP/0/RP0/CPU0:router(config-track)# end</pre> <p>or</p> <pre>RP/0/RP0/CPU0:router(config-track)# commit</pre>	<ul style="list-style-type: none"> • When you issue the end command, the system prompts you to commit changes: <ul style="list-style-type: none"> 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.

Tracking IP Route Reachability

When a host or a network goes down on a remote site, routing protocols notify the router and the routing table is updated accordingly. The routing process is configured to notify the tracking process when the route state changes due to a routing update.

A tracked object is considered up when a routing table entry exists for the route and the route is accessible.

SUMMARY STEPS

1. **configure**
2. **track** *track-name*
3. **type route reachability**
4. Use one of the following commands:
 - **vrf** *vrf-table-name*
 - **route ipv4** *IP-prefix/mask*
5. **exit**
6. (Optional) **delay** {**up** *seconds* | **down** *seconds*}
7. Use the **commit** or **end** command.

DETAILED STEPS

	Command or Action	Purpose
Step 1	configure Example: RP/0/RP0/CPU0:router# configure	Enters global configuration mode.
Step 2	track track-name Example: RP/0/RP0/CPU0:router(config)# track track1	Enters track configuration mode. <ul style="list-style-type: none"> • <i>track-name</i>—Specifies a name for the object to be tracked. Note Special characters are not allowed in a <i>track-name</i> .
Step 3	type route reachability Example: RP/0/RP0/CPU0:router(config-track)# type route reachability vrf internet	Configures the routing process to notify the tracking process when the state of the route changes due to a routing update.
Step 4	Use one of the following commands: <ul style="list-style-type: none"> • vrf vrf-table-name • route ipv4 IP-prefix/mask Example: RP/0/RP0/CPU0:router(config-track-route)# vrf vrf-table-4 OR RP/0/RP0/CPU0:router(config-track-route)# route ipv4 10.56.8.10/16	Configures the type of IP route to be tracked, which can consist of either of the following, depending on your router type: <ul style="list-style-type: none"> • <i>vrf-table-name</i>—A VRF table name. • <i>IP-prefix/mask</i>—An IP prefix consisting of the network and subnet mask (for example, 10.56.8.10/16).
Step 5	exit Example: RP/0/RP0/CPU0:router(config-track-line-prot)# exit	Exits the track line protocol configuration mode.
Step 6	(Optional) delay {up seconds down seconds} Example: RP/0/RP0/CPU0:router(config-track)# delay up 10	Schedules the delay that can occur between tracking whether the object is up or down.
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: <ul style="list-style-type: none"> • Yes — Saves configuration changes and exits the configuration session.

	Command or Action	Purpose
		<ul style="list-style-type: none"> • No —Exits the configuration session without committing the configuration changes. • Cancel —Remains in the configuration mode, without committing the configuration changes.

Building a Track Based on a List of Objects

Perform this task in the global configuration mode to create a tracked list of objects (which, in this case, are lists of interfaces or prefixes) using a Boolean expression to determine the state of the list.

A tracked list contains one or more objects. The Boolean expression enables two types of calculations by using either AND or OR operators. For example, when tracking two interfaces, using the AND operator, up means that *both* interfaces are up, and down means that *either* interface is down.



Note An object must exist before it can be added to a tracked list.

The NOT operator is specified for one or more objects and negates the state of the object.

After configuring the tracked object, you must associate the interface whose state should be tracked and you may optionally specify the number of seconds to wait before the tracking object polls the interface for its state.

SUMMARY STEPS

1. **configure**
2. **track** *track-name*
3. **type list boolean** { **and** | **or** }
4. **object** *object-name* [**not**]
5. **exit**
6. (Optional) **delay** { **up** *seconds* | **down** *seconds* }
7. Use one of the following commands:
 - **end**
 - **commit**

DETAILED STEPS

	Command or Action	Purpose
Step 1	configure Example: RP/0/RP0/CPU0:router# <code>configure</code>	Enters global configuration mode.
Step 2	track <i>track-name</i>	Enters track configuration mode.

	Command or Action	Purpose
	<p>Example:</p> <pre>RP/0/RP0/CPU0:router(config)# track track1</pre>	<ul style="list-style-type: none"> • <i>track-name</i>—Specifies a name for the object to be tracked. <p>Note Special characters are not allowed in a <i>track-name</i>.</p>
Step 3	<p>type list boolean { and or }</p> <p>Example:</p> <pre>RP/0/RP0/CPU0:router(config-track)# type list boolean and</pre>	<p>Configures a Boolean list object and enters track list configuration mode.</p> <ul style="list-style-type: none"> • boolean—Specifies that the state of the tracked list is based on a Boolean calculation. • and—Specifies that the list is up if all objects are up, or down if one or more objects are down. For example when tracking two interfaces, up means that both interfaces are up, and down means that either interface is down. • or—Specifies that the list is up if at least one object is up. For example, when tracking two interfaces, up means that either interface is up, and down means that both interfaces are down.
Step 4	<p>object object-name [not]</p> <p>Example:</p> <pre>RP/0/RP0/CPU0:router(config-track-list)# object 3 not</pre>	<p>Specifies the object to be tracked by the list</p> <ul style="list-style-type: none"> • <i>object-name</i>—Name of the object to track. • not—Negates the state of the object.
Step 5	<p>exit</p> <p>Example:</p> <pre>RP/0/RP0/CPU0:router(config-track-line-prot)# exit</pre>	<p>Exits the track line protocol configuration mode.</p>
Step 6	<p>(Optional) delay {up seconds down seconds}</p> <p>Example:</p> <pre>RP/0/RP0/CPU0:router(config-track)# delay up 10</pre>	<p>Schedules the delay that can occur between tracking whether the object is up or down.</p>
Step 7	<p>Use one of the following commands:</p> <ul style="list-style-type: none"> • end • commit <p>Example:</p> <pre>RP/0/RP0/CPU0:router(config-track)# end</pre> <p>OR</p> <pre>RP/0/RP0/CPU0:router(config-track)# commit</pre>	<p>Saves configuration changes.</p> <ul style="list-style-type: none"> • When you issue the end command, the system prompts you to commit changes: <pre>Uncommitted changes found, commit them before exiting (yes/no/cancel)? [cancel]:</pre> <ul style="list-style-type: none"> • Entering yes saves configuration changes to the running configuration file, exits the configuration session, and returns the router to EXEC mode.

	Command or Action	Purpose
		<ul style="list-style-type: none"> • 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.

Building a Track Based on a List of Objects - Threshold Percentage

Perform this task in the global configuration mode to create a tracked list of objects (which, in this case, are lists of interfaces or prefixes) using a threshold percentage to determine the state of the list.

SUMMARY STEPS

1. **configure**
2. **track** *track-name*
3. **type list threshold percentage**
4. **object** *object-name*
5. **threshold percentage up percentage down percentage**
6. 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 global configuration mode.
Step 2	track <i>track-name</i> Example: RP/0/RP0/CPU0:router(config)# track track1	Enters track configuration mode. <ul style="list-style-type: none"> • <i>track-name</i>—Specifies a name for the object to be tracked. <p>Note Special characters are not allowed in a <i>track-name</i>.</p>

	Command or Action	Purpose
Step 3	<p>type list threshold percentage</p> <p>Example:</p> <pre>RP/0/RP0/CPU0:router(config-track)# type list threshold percentage</pre>	Configures a track of type threshold percentage list.
Step 4	<p>object <i>object-name</i></p> <p>Example:</p> <pre>RP/0/RP0/CPU0:router(config-track-list-threshold)# object 1 RP/0/RP0/CPU0:router(config-track-list-threshold)# object 2 RP/0/RP0/CPU0:router(config-track-list-threshold)# object 3 RP/0/RP0/CPU0:router(config-track-list-threshold)# object 4</pre>	Configures object 1, object 2, object 3 and object 4 as members of track type track1.
Step 5	<p>threshold percentage up <i>percentage</i> down <i>percentage</i></p> <p>Example:</p> <pre>RP/0/RP0/CPU0:router(config-track-list-threshold)# threshold percentage up 50 down 33</pre>	<p>Configures the percentage of objects that need to be UP or DOWN for the list to be considered UP or Down respectively.</p> <p>For example, if object 1, object 2, and object 3 are in the UP state and object 4 is in the DOWN state, the list is considered to be in the UP state.</p>
Step 6	<p>Use one of the following commands:</p> <ul style="list-style-type: none"> • end • commit <p>Example:</p> <pre>RP/0/RP0/CPU0:router(config-track)# end</pre> <p>or</p> <pre>RP/0/RP0/CPU0:router(config-track)# commit</pre>	<p>Saves configuration changes.</p> <ul style="list-style-type: none"> • When you issue the end command, the system prompts you to commit changes: <pre>Uncommitted changes found, commit them before exiting (yes/no/cancel)? [cancel]:</pre> <ul style="list-style-type: none"> • 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.

Building a Track Based on a List of Objects - Threshold Weight

Perform this task in the global configuration mode to create a tracked list of objects (which, in this case, are lists of interfaces or prefixes) using a threshold weight to determine the state of the list.

SUMMARY STEPS

1. **configure**
2. **track** *track-name*
3. **type list threshold weight**
4. **object** *object-name* **weight** *weight*
5. **threshold weight up** *weight* **down** *weight*
6. 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 global configuration mode.
Step 2	track <i>track-name</i> Example: RP/0/RP0/CPU0:router(config)# track track1	Enters track configuration mode. <ul style="list-style-type: none"> • <i>track-name</i>—Specifies a name for the object to be tracked. Note Special characters are not allowed in a <i>track-name</i> .
Step 3	type list threshold weight Example: RP/0/RP0/CPU0:router(config-track)# type list threshold weight	Configures a track of type, threshold weighted list.
Step 4	object <i>object-name</i> weight <i>weight</i> Example: RP/0/RP0/CPU0:router(config-track-list-threshold)# object 1 weight 10 RP/0/RP0/CPU0:router(config-track-list-threshold)# object 2 weight 5 RP/0/RP0/CPU0:router(config-track-list-threshold)# object 3 weight 3	Configures object 1, object 2 and object 3 as members of track t1 and with weights 10, 5 and 3 respectively.

	Command or Action	Purpose
Step 5	<p>threshold weight up <i>weight</i> down <i>weight</i></p> <p>Example:</p> <pre>RP/0/RP0/CPU0:router(config-track-list-threshold)# threshold weight up 10 down 5</pre>	Configures the range of weights for the objects that need to be UP or DOWN for the list to be considered UP or DOWN respectively. In this example, the list is considered to be in the DOWN state because objects 1 and 2 are in the UP state and the cumulative weight is 15 (not in the 10-5 range).
Step 6	<p>Use one of the following commands:</p> <ul style="list-style-type: none"> • end • commit <p>Example:</p> <pre>RP/0/RP0/CPU0:router(config-track)# end</pre> <p>or</p> <pre>RP/0/RP0/CPU0:router(config-track)# commit</pre>	<p>Saves configuration changes.</p> <ul style="list-style-type: none"> • When you issue the end command, the system prompts you to commit changes: <pre>Uncommitted changes found, commit them before exiting (yes/no/cancel)? [cancel]:</pre> <ul style="list-style-type: none"> • 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.

Tracking IPSLA Reachability

Use this task to enable the tracking of the return code of IP service level agreement (SLA) operations.

SUMMARY STEPS

1. **configure**
2. **track** *track-name*
3. **type rtr** *ipsla-no* **reachability**
4. Use the **commit** or **end** command.

DETAILED STEPS

	Command or Action	Purpose
Step 1	<p>configure</p> <p>Example:</p>	Enters global configuration mode.

	Command or Action	Purpose
	RP/0/RP0/CPU0:router# configure	
Step 2	track track-name Example: RP/0/RP0/CPU0:router (config)# track t1	Enters track configuration mode. Note Special characters are not allowed in a <i>track-name</i> .
Step 3	type rtr ipsla-no reachability Example: RP/0/RP0/CPU0:router (config-track)# type rtr 100 reachability	Specifies the IP SLA operation ID to be tracked for reachability. Values for the <i>ipsla-no</i> can range from 1 to 2048.
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: <ul style="list-style-type: none"> • 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 IPSLA Tracking: Example

This example shows the configuration of IPSLA tracking:

```
RP/0/RP0/CPU0:router (config)# track track1
RP/0/RP0/CPU0:router (config-track)# type rtr 1 reachability
RP/0/RP0/CPU0:router (config-track)# delay up 5
RP/0/RP0/CPU0:router (config-track)# delay down 10
```

Tracking BGP Neighbor Address-Family State

Perform this task in global configuration mode to track the BGP neighbor address-family state.

By tracking this object, you can detect the connectivity state of the neighbor . A tracked object is up when a state of the neighbor is up. Associate the neighbor whose state must be tracked after configuring the tracked object. Based on the state of the neighbor you can reroute the traffic.

Configuration Example

```
/* Track neighbor address-family state */
Router# configure
Router (config)# track neighbor-A
Router (config-track)# type bgp neighbor address-family state
```

```
Router(config-track-bgp-nbr-af)# address-family 12vpn evpn
Router(config-track-bgp-neighbor)# neighbor 172.16.0.1
Router(config-track-bgp-neighbor)# exit
```

Configuration Examples for Configuring Object Tracking

Tracking Whether the Interface Is Up or Down: Running Configuration Example

```
track connection100
  type list boolean and
    object object3 not
    delay up 10
  !
interface service-ipsec 23
  line-protocol track connection100
  !
```

Tracking the Line Protocol State of an Interface: Running Configuration Example

In this example, traffic arrives from interface service-ipsec1 and exits through interface gigabitethernet0/0/0/3:

```
track IPsec1
  type line-protocol state
    interface gigabitethernet0/0/0/3
  !
interface service-ipsec 1
  ipv4 address 70.0.0.1 255.255.255.0
  profile vrfl_profile_ipsec
  line-protocol track IPsec1
  tunnel source 80.0.0.1
  tunnel destination 80.0.0.2
  service-location preferred-active 0/0/1
  !
```

This example displays the output from the **show track** command after performing the previous example:

```
RP/0/RP0/CPU0:router# show run track

Track IPsec1
Interface GigabitEthernet0_0_0_3 line-protocol
!
Line protocol is UP
1 change, last change 10:37:32 UTC Thu Sep 20 2007
Tracked by:
service-ipsec1
!
```

Tracking IP Route Reachability: Running Configuration Example

In this example, traffic arriving from interface service-ipsec1 has its destination in network 7.0.0.0/24. This tracking procedure follows the state of the routing protocol prefix to signal when there are changes in the routing table.

```
track PREFIX1
  type route reachability
  route ipv4 7.0.0.0/24
  !
  interface service-ipsec 1
  vrf 1
  ipv4 address 70.0.0.2 255.255.255.0
  profile vrf_1_ipsec
  line-protocol track PREFIX1
  tunnel source 80.0.0.2
  tunnel destination 80.0.0.1
  service-location preferred-active 0/2/0
```

Building a Track Based on a List of Objects: Running Configuration Example

In this example, traffic arriving from interface service-ipsec1 exits through interface gigabitethernet0/0/0/3 and interface ATM 0/2/0/0.1. The destination of the traffic is at network 7.0.0.0/24.

If either one of the interfaces or the remote network goes down, the flow of traffic must stop. To do this, we use a Boolean AND expression.

```
track C1
  type route reachability
  route ipv4 3.3.3.3/32
  !
  !
track C2
  type route reachability
  route ipv4 1.2.3.4/32
  !
  !
track C3
  type route reachability
  route ipv4 10.0.20.2/32
  !
  !
track C4
  type route reachability
  route ipv4 10.0.20.0/24
  !
  !
track OBJ
  type list boolean and
  object C1
  object C2
  !
  !
track OBJ2
  type list boolean or
  object C1
```

```
object C2
!
```

Configuring IPSLA based Object Tracking: Configuration Example

This example shows the configuration of IPSLA based object tracking, including the ACL and IPSLA configuration:

ACL configuration:

```
RP/0/RP0/CPU0:router(config)# ipv4 access-list abf-track
RP/0/RP0/CPU0:router(config-ipv4-acl)# 10 permit any nexthop track track1 1.2.3.4
```

Object tracking configuration:

```
RP/0/RP0/CPU0:router(config)# track track1
RP/0/RP0/CPU0:router(config-track)# type rtr 1 reachability
RP/0/RP0/CPU0:router(config-track)# delay up 5
RP/0/RP0/CPU0:router(config-track)# delay down 10
```

IPSLA configuration:

```
RP/0/RP0/CPU0:router(config)# ipsla
RP/0/RP0/CPU0:router(config-ipsla)# operation 1
RP/0/RP0/CPU0:router(config-ipsla-op)# type icmp echo
RP/0/RP0/CPU0:router(config-ipsla-icmp-echo)# source address 2.3.4.5
RP/0/RP0/CPU0:router(config-ipsla-icmp-echo)# destination address 1.2.3.4
RP/0/RP0/CPU0:router(config-ipsla-icmp-echo)# frequency 60
RP/0/RP0/CPU0:router(config-ipsla-icmp-echo)# exit
RP/0/RP0/CPU0:router(config-ipsla-op)# exit
RP/0/RP0/CPU0:router(config-ipsla)# schedule operation 1
RP/0/RP0/CPU0:router(config-ipsla-sched)# start-time now
RP/0/RP0/CPU0:router(config-ipsla-sched)# life forever
```

Additional References

The following sections provide references related to implementing object tracking for IPsec network security.

Related Documents

Related Topic	Document Title
IP SLA configuration information	<i>Implementing IP Service Level Agreements on</i> module in <i>System Monitoring Configuration Guide for Cisco NCS 5500 Series Routers</i>
IP SLA commands	<i>IP Service Level Agreement Commands on</i> module in <i>System Monitoring Command Reference for Cisco NCS 5500 Series Routers and Cisco NCS 540 and NCS 560 Series Routers</i>
Object tracking commands	<i>Object Tracking Commands on</i> module in

Standards

Standards	Title
No new or modified standards are supported by this feature, and support for existing standards has not been modified by this feature.	—

MIBs

MIBs	MIBs Link
—	To locate and download MIBs using Cisco IOS XR software, use the Cisco MIB Locator found at the following URL and choose a platform under the Cisco Access Products menu: https://cfmng-stg.cisco.com/mibs .

RFCs

RFCs	Title
RFC 2401	<i>Security Architecture for the Internet Protocol</i>

Technical Assistance

Description	Link
The Cisco Technical Support website contains thousands of pages of searchable technical content, including links to products, technologies, solutions, technical tips, and tools. Registered Cisco.com users can log in from this page to access even more content.	http://www.cisco.com/cisco/web/support/index.html



CHAPTER 7

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, on page 67](#)
- [Information About Implementing CDP, on page 67](#)
- [How to Implement CDP on Cisco IOS XR Software, on page 69](#)
- [Configuration Examples for Implementing CDP, on page 75](#)

Prerequisites for Implementing CDP

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.



Note CDP is an optional package. You must check if this package is installed on your system by running the command **show install active summary**.

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 task explains how to enable CDP globally on the router and then enable CDP on an interface.

SUMMARY STEPS

1. **configure**
2. **cdp**
3. **interface** *type interface-path-id*
4. **cdp**
5. Use the **commit** or **end** command.

DETAILED STEPS

	Command or Action	Purpose
Step 1	configure Example: RP/0/RP0/CPU0:router# configure	Enters global configuration mode.
Step 2	cdp Example: RP/0/RP0/CPU0:router(config)# cdp	Enables CDP globally.
Step 3	interface <i>type interface-path-id</i> Example: RP/0/RP0/CPU0:router(config)# int TenGigE 0/5/0/11/1	Enters interface configuration mode.
Step 4	cdp Example: RP/0/RP0/CPU0:router(config-if)# cdp	Enables CDP on an interface.
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: <ul style="list-style-type: none"> • Yes — Saves configuration changes and exits the configuration session.

	Command or Action	Purpose
		<ul style="list-style-type: none"> • No —Exits the configuration session without committing the configuration changes. • Cancel —Remains in the configuration session, without committing the configuration changes.

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.

SUMMARY STEPS

1. **configure**
2. **cdp advertise v1**
3. **cdp holdtime** *seconds*
4. **cdp timer** *seconds*
5. Use the **commit** or **end** command.
6. (Optional) **show cdp**

DETAILED STEPS

	Command or Action	Purpose
Step 1	configure Example: <pre>RP/0/RP0/CPU0:router# configure</pre>	Enters global configuration mode.
Step 2	cdp advertise v1 Example: <pre>RP/0/RP0/CPU0:router(config)# cdp advertise v1</pre>	Configures CDP to use only version 1 (CDPv1) in communicating with neighboring devices. <ul style="list-style-type: none"> • 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 <i>seconds</i> Example: <pre>RP/0/RP0/CPU0:router(config)# cdp holdtime 30</pre>	Specifies the amount of time that the receiving networking device will hold a CDP packet sent from the router before discarding it.

	Command or Action	Purpose
		<ul style="list-style-type: none"> By default, when CDP is enabled, the receiving networking device holds a CDP packet for 180 seconds before discarding it. <p>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.</p> <ul style="list-style-type: none"> In this example, the value of hold-time for the <i>seconds</i> argument is set to 30.
Step 4	cdp timer <i>seconds</i> Example: <pre>RP/0/RP0/CPU0:router(config)# cdp timer 20</pre>	Specifies the frequency at which CDP update packets are sent. <ul style="list-style-type: none"> By default, when CDP is enabled, CDP update packets are sent at a frequency of once every 60 seconds. <p>Note A lower timer setting causes CDP updates to be sent more frequently.</p> <ul style="list-style-type: none"> 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.	<p>commit —Saves the configuration changes and remains within the configuration session.</p> <p>end —Prompts user to take one of these actions:</p> <ul style="list-style-type: none"> 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: <pre>RP/0/RP0/CPU0:router# show cdp</pre>	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.

SUMMARY STEPS

1. **show cdp entry** *{* | entry-name}* [**protocol** | **version**]
2. **show cdp interface** [*type interface-path-id* | **location node-id**]
3. **show cdp neighbors** [*type interface-path-id* | **location node-id**] [**detail**]
4. **show cdp traffic** [**location node-id**]

DETAILED STEPS

	Command or Action	Purpose
Step 1	show cdp entry <i>{* entry-name}</i> [protocol version] Example: RP/0/RSP0/CPU0:router# show cdp entry *	Displays information about a specific neighboring device or all neighboring devices discovered using CDP.
Step 2	show cdp interface [<i>type interface-path-id</i> location node-id] Example: RP/0/RSP0/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 [<i>type interface-path-id</i> location node-id] [detail] Example: RP/0/RSP0/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/RSP0/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
asr9k-rtr1    Te0/5/0/11/1  152      R           ASR9K Ser  Te0/1/0/9
asr9k-rtr1    Te0/5/0/11/2  156      R           ASR9K Ser  Te0/1/0/10
asr9k-rtr1    Te0/5/0/11/3  160      R           ASR9K Ser  Te0/1/0/11
```

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 TenGigE 0/5/0/11/1 detail
```

```
-----  
Device ID: asr9k-rtr1  
SysName : asr9k-rtr1  
Entry address(es):  
IPv4 address: 90.0.0.2  
Platform: cisco ASR9K Series, Capabilities: Router  
Interface: TenGigE 0/5/0/11/1  
Port ID (outgoing port): TenGigE 0/1/0/9  
Holdtime : 155 sec  
  
Version :  
Cisco IOS XR Software, Version 5.3.1.10I[Default]  
Copyright (c) 2015 by Cisco Systems, Inc.  
  
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 asr9k-rtr1
```

```
-----  
Device ID: asr9k-rtr1  
SysName : asr9k-rtr1  
Entry address(es):  
IPv4 address: 110.0.0.2  
Platform: cisco ASR9K Series, Capabilities: Router  
Interface: TenGigE 0/5/0/11/3  
Port ID (outgoing port): TenGigE 0/1/0/11  
Holdtime : 173 sec  
  
Version :  
Cisco IOS XR Software, Version 5.3.1.10I[Default]  
Copyright (c) 2015 by Cisco Systems, Inc.  
  
advertisement version: 2  
Duplex: full  
  
-----  
Device ID: asr9k-rtr1  
SysName : asr9k-rtr1  
Entry address(es):  
IPv4 address: 100.0.0.2  
Platform: cisco ASR9K Series, Capabilities: Router  
Interface: TenGigE 0/5/0/11/2  
Port ID (outgoing port): TenGigE 0/1/0/10  
Holdtime : 169 sec  
  
Version :  
Cisco IOS XR Software, Version 5.3.1.10I[Default]  
Copyright (c) 2015 by Cisco Systems, Inc.  
  
advertisement version: 2  
Duplex: full  
  
-----  
Device ID: asr9k-rtr1  
SysName : asr9k-rtr1
```

```

Entry address(es):
IPv4 address: 90.0.0.2
Platform: cisco ASR9K Series, Capabilities: Router
Interface: TenGigE 0/5/0/11/1
Port ID (outgoing port): TenGigE 0/1/0/10
Holdtime : 165 sec

Version :
Cisco IOS XR Software, Version 5.3.1.10I[Default]
Copyright (c) 2015 by Cisco Systems, Inc.

advertisement version: 2
Duplex: full

```

The following is sample output for the **show cdp interface** command. In this example, CDP information related to Packet over SONET/SDH (POS) interface 0/4/0/0 is displayed.

```

RP/0/RP0/CPU0:router# show cdp interface TenGigE 0/5/0/11/1

TenGigE 0/5/0/11/1 is Up
  Encapsulation ether
  Sending CDP packets every 20 seconds
  Holdtime is 30 seconds

```

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

```

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

CDP counters :
  Packets output: 250, Input: 120
  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: 250, Input: 120
  Unrecognize Hdr version: 0, File open failed: 0

```

The following is sample output for the **show cdp traffic** command. In this example, the optional **location** keyword and *node-id* argument are used to display information about the traffic gathered between devices using CDP from the specified node.

```

RP/0/RP0/CPU0:router# show cdp traffic 0/5/CPU0

CDP counters :
  Packets output: 318, Input: 141
  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: 318, Input: 141
  Unrecognize Hdr version: 0, File open failed: 0

```


Configuration Examples for Implementing CDP

Enabling CDP: Example

The following example shows how to configure CDP globally and then enable CDP on Ethernet interface TenGigE 0/5/0/11/1:

```
cdp
interface 0/5/0/11/1
cdp
```

Modifying Global CDP Settings: Example

The following example shows how to modify global CDP settings. In this example, the timer setting is set to 20 seconds, the hold-time setting is set to 30 seconds, and the version of CDP used to communicate with neighboring devices is set to CDPv1:

```
cdp timer 20
cdp holdtime 30
cdp advertise v1
```

The following example shows how to use the **show cdp** command to verify the CDP global settings:

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

Global CDP information:
Sending CDP packets every 20 seconds
Sending a holdtime value of 30 seconds
Sending CDPv2 advertisements is not enabled
```




CHAPTER 8

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, on page 77](#)
- [Information About Periodic MIB Data Collection and Transfer, on page 77](#)
- [How to Configure Periodic MIB Data Collection and Transfer, on page 79](#)
- [Periodic MIB Data Collection and Transfer: Example, on page 85](#)

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.

SUMMARY STEPS

1. **configure**
2. **snmp-server mib bulkstat object-list** *list-name*
3. **add** {oid | *object-name*}
4. Use the **commit** or **end** command.

DETAILED STEPS

	Command or Action	Purpose
Step 1	configure Example: <pre>RP/0/RP0/CPU0:router# configure</pre>	Enters global configuration mode.
Step 2	snmp-server mib bulkstat object-list <i>list-name</i> Example: <pre>snmp-server mib bulkstat object-list ifMib</pre>	Defines an SNMP bulk statistics object list and enters bulk statistics object list configuration mode.
Step 3	add {oid <i>object-name</i> }	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.

	Command or Action	Purpose
		<p>end —Prompts user to take one of these actions:</p> <ul style="list-style-type: none"> • 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.

SUMMARY STEPS

1. **configure**
2. **snmp-server mib bulkstat schema** *schema-name*
3. **object-list** *list-name*
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*
5. **poll-interval** *minutes*
6. Use the **commit** or **end** command.

DETAILED STEPS

	Command or Action	Purpose
Step 1	<p>configure</p> <p>Example:</p> <pre>RP/0/RP0/CPU0:router# configure</pre>	Enters global configuration mode.
Step 2	<p>snmp-server mib bulkstat schema <i>schema-name</i></p> <p>Example:</p> <pre>RP/0/RP0/CPU0:router(config)# snmp-server mib bulkstat schema intE0 RP/0/RP0/CPU0:router(config-bulk-sc)#</pre>	Names the bulk statistics schema and enters bulk statistics schema mode.

	Command or Action	Purpose
<p>Step 3</p>	<p>object-list <i>list-name</i></p> <p>Example:</p> <pre>RP/0/RP0/CPU0:router(config-bulk-sc)# object-list ifMib</pre>	<p>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.</p>
<p>Step 4</p>	<p>Do one of the following:</p> <ul style="list-style-type: none"> • instance exact {interface <i>interface-id</i> [sub-if] oid <i>oid</i>} • instance wild {interface <i>interface-id</i> [sub-if] oid <i>oid</i>} • instance range start <i>oid</i> end <i>oid</i> • instance repetition <i>oid</i> max <i>repeat-number</i> <p>Example:</p> <pre>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</pre>	<p>Specifies the instance information for objects in this schema:</p> <ul style="list-style-type: none"> • 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. <p>Note Only one instance command can be configured per schema. If multiple instance commands are executed, the earlier ones are overwritten by new commands.</p>
<p>Step 5</p>	<p>poll-interval <i>minutes</i></p> <p>Example:</p> <pre>RP/0/RP0/CPU0:router(config-bulk-sc)# poll-interval 10</pre>	<p>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.</p>
<p>Step 6</p>	<p>Use the commit or end command.</p>	<p>commit —Saves the configuration changes and remains within the configuration session.</p> <p>end —Prompts user to take one of these actions:</p> <ul style="list-style-type: none"> • 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.

SUMMARY STEPS

1. **configure**
2. **snmp-server mib bulkstat transfer-id** *transfer-id*
3. **buffer-size** *bytes*
4. **format** {**bulkBinary** | **bulkASCII** | **schemaASCII**}
5. **schema** *schema-name*
6. **transfer-interval** *minutes*
7. **url primary** *url*
8. **url secondary** *url*
9. **retry** *number*
10. **retain** *minutes*
11. **enable**
12. **commit** *minutes*

DETAILED STEPS

	Command or Action	Purpose
Step 1	configure Example: RP/0/RP0/CPU0:router# configure	Enters global configuration mode.
Step 2	snmp-server mib bulkstat transfer-id <i>transfer-id</i> Example: RP/0/RP0/CPU0:router(config)# snmp-server mib bulkstat transfer bulkstat1	Identifies the transfer configuration with a name (<i>transfer-id</i> argument) and enters bulk statistics transfer configuration mode.
Step 3	buffer-size <i>bytes</i> 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.

	Command or Action	Purpose
		<p>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.</p>
Step 4	<p>format {bulkBinary bulkASCII schemaASCII}</p> <p>Example:</p> <pre>RP/0/RP0/CPU0:router(config-bulk-tr)# format schemaASCII</pre>	<p>(Optional) Specifies the format of the bulk statistics data file (VFile). The default is schemaASCII.</p> <p>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.</p>
Step 5	<p>schema <i>schema-name</i></p> <p>Example:</p> <pre>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</pre>	<p>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).</p>
Step 6	<p>transfer-interval <i>minutes</i></p> <p>Example:</p> <pre>RP/0/RP0/CPU0:router(config-bulk-tr)# transfer-interval 20</pre>	<p>(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.</p>
Step 7	<p>url primary <i>url</i></p> <p>Example:</p> <pre>RP/0/RP0/CPU0:router(config-bulk-tr)# url primary ftp://user:password@host/folder/bulkstat1</pre>	<p>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.</p>
Step 8	<p>url secondary <i>url</i></p> <p>Example:</p> <pre>RP/0/RP0/CPU0:router(config-bulk-tr)# url secondary tftp://10.1.0.1/tftpboot/user/bulkstat1</pre>	<p>(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.</p>
Step 9	<p>retry <i>number</i></p> <p>Example:</p> <pre>RP/0/RP0/CPU0:router(config-bulk-tr)# retry 1</pre>	<p>(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.</p>

	Command or Action	Purpose
		<p>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.</p> <p>If all retries fail, the next normal transfer occurs after the configured transfer-interval time.</p>
Step 10	<p>retain <i>minutes</i></p> <p>Example:</p> <pre>RP/0/RP0/CPU0:router(config-bulk-tr)# retain 60</pre>	<p>(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.</p> <p>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.</p>
Step 11	<p>enable</p> <p>Example:</p> <pre>RP/0/RP0/CPU0:router(config-bulk-tr)# enable</pre>	<p>Begins the bulk statistics data collection and transfer process for this configuration.</p> <ul style="list-style-type: none"> • 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	<p>commit <i>minutes</i></p> <p>Example:</p> <pre>RP/0/RP0/CPU0:router(config-bulk-tr)# retain 60</pre>	<p>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.</p>

	Command or Action	Purpose
		<p>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.</p>

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/dumppdc
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 9

Configuring Flexible Command Line Interface

This module describes how to configure and use flexible command line interface (CLI) configuration groups.

- [Flexible CLI Configuration Groups, on page 87](#)
- [Flexible Configuration Restrictions, on page 87](#)
- [Configuring a Configuration Group, on page 89](#)
- [Verifying the Configuration of Configuration Groups, on page 91](#)
- [Regular Expressions in Configuration Groups, on page 93](#)
- [Configuration Examples for Flexible CLI Configuration, on page 104](#)

Flexible CLI Configuration Groups

Flexible command line interface (CLI) configuration groups provide the ability to minimize repetitive configurations by defining a series of configuration statements in a configuration group, and then applying this group to multiple hierarchical levels in the router configuration tree.

Flexible CLI configuration groups utilize regular expressions that are checked for a match at multiple submodes of the configuration tree based on where the group is applied within the hierarchy. If a match is found at a configuration submode, the corresponding configuration defined in the group is inherited within the matched submode.

Flexible CLI configuration groups also provide an auto-inheritance feature. Auto-inheritance means that any change done to a CLI configuration group is automatically applied to the configuration in any matched submodes that have an `apply-group` at that hierarchical level. This allows you to make a configuration change or addition once, and have it applied automatically in multiple locations, depending on where you have applied the flexible CLI configuration group.

Flexible Configuration Restrictions

Note these restrictions while using flexible configuration groups:

- Flexible CLI configuration groups are not supported in administration configurations and corresponding `apply-groups` are not supported in administration configurations.
- Use of preconfigured interfaces in configuration groups is not supported.
- Downgrading from an image that supports configuration groups to an image that does not support them is not supported.

- Access lists, quality of service and route policy configurations do not support the use of configuration groups. Configurations such as these are not valid:

```
group g-not-supported
  ipv4 access-list ...
  !
  ipv6 access-list ...
  !
  ethernet-service access-list ...
  !
  class-map ...
  !
  policy-map ...
  !
  route-policy ...
  !
end-group
```

You can, however, reference such configurations, as shown in this example:

```
group g-reference-ok
  router bgp 6500
  neighbor 7::7
  remote-as 65000
  bfd fast-detect
  update-source Loopback300
  graceful-restart disable
  address-family ipv6 unicast
    route-policy test1 in
    route-policy test2 out
  soft-reconfiguration inbound always
  !
  !
  !
  interface Bundle-Ether1005
  bandwidth 10000000
  mtu 9188
    service-policy output input_1
  load-interval 30
  !
end-group
```

- Some regular expressions are not supported within groups. For example, ‘?’ , ‘|’ and ‘\$,’ are not supported within groups. Also some characters such as /d and /w are not supported.

- The choice operator “|” to express multiple match expressions within a regular expression is not supported. For example, these expressions are not supported:

Gig.*|Gig.*\..*—To match on either Gigabit Ethernet main interfaces or Gigabit Ethernet sub-interfaces.

Gig.*0/0/0/[1-5]|Gig.*0/0/0/[10-20]—To match on either Gig.*0/0/0/[1-5] or Gig.*0/0/0/[10-20].

'TenGigE.*|HundredGigE.*—To match on either TenGigE.* or HundredGigE.*.

- Commands that require a node identifier for the **location** keyword are not supported. For example, this configuration is not supported:

```
lpts pifib hardware police location 0/RP0/CPU0
```

- Overlapping regular expressions within a configuration group for the same configuration are not supported. For example:

```
group G-INTERFACE
interface 'gig.*a.*'
    mtu 1500
!
interface 'gig.*e.* '
    mtu 2000
!
end-group

interface gigabitethernet0/0/0/* ---- where * is 0 to 79 or 0 to 39
    apply-group G-INTERFACE
```

This configuration is not permitted because it cannot be determined whether the `interface GigabitEthernet0/0/0/*` configuration inherits `mtu 1500` or `mtu 2000`. Both expressions in the configuration group match `GigabitEthernet0/0/0/*`.

- Up to eight configuration groups are permitted on one `apply-group` command.

Configuring a Configuration Group

A configuration group includes a series of configuration statements that can be used in multiple hierarchical levels in the router configuration tree. By using regular expressions in a configuration group, you can create generic commands that can be applied in multiple instances.

Use this task to create and use a configuration group.



Note Flexible CLI configurations are not available through the XML interface.

SUMMARY STEPS

1. **configure**
2. **group** *group-name*
3. Enter configuration commands, starting from global configuration mode. Use regular expressions for interface names and other variable instances.
4. **end-group**
5. **apply-group**

DETAILED STEPS

Step 1 **configure**

Example:

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

Enters global configuration mode.

Step 2 `group group-name`**Example:**

```
RP/0/RP0/CPU0:router(config)# group g-interf
```

Specifies a name for a configuration group and enters group configuration mode to define the group. The *group-name* argument can have up to 32 characters and cannot contain any special characters.

Step 3 Enter configuration commands, starting from global configuration mode. Use regular expressions for interface names and other variable instances.**Example:**

```
RP/0/RP0/CPU0:router(config)# group g-interf
RP/0/RP0/CPU0:router(config-GRP)# interface 'GigabitEthernet.*'
RP/0/RP0/CPU0:router(config-GRP-if)# mtu 1500
```

Specifies the configuration statements that you want included in this configuration group.

For more information regarding the use of regular expressions, see [Configuration Group Inheritance with Regular Expressions: Example, on page 102](#). This example is applicable to all Gigabit Ethernet interfaces.

Step 4 `end-group`**Example:**

```
RP/0/RP0/CPU0:router(config-GRP-if)# end-group
```

Completes the configuration of a configuration group and exits to global configuration mode.

Step 5 `apply-group`**Example:**

```
RP/0/RP0/CPU0:router(config)# interface GigabitEthernet0/2/0/0
RP/0/RP0/CPU0:router(config-if)# apply-group g-interf
```

Adds the configuration of the configuration group into the router configuration applicable at the location that the group is applied. Groups can be applied in multiple locations, and their effect depends on the location and context.

The MTU value from the group `g-interf` is applied to the interface `GigabitEthernet0/2/0/0`. If this group is applied in global configuration mode, the MTU value is inherited by all Gigabit Ethernet interfaces that do not have an MTU value configured.

Simple Configuration Group: Example

This example shows how to use configuration groups to add a global configuration to the system:

```
RP/0/RP0/CPU0:router(config)# group g-logging
RP/0/RP0/CPU0:router(config-GRP)# logging trap notifications
RP/0/RP0/CPU0:router(config-GRP)# logging console debugging
RP/0/RP0/CPU0:router(config-GRP)# logging monitor debugging
RP/0/RP0/CPU0:router(config-GRP)# logging buffered 10000000
RP/0/RP0/CPU0:router(config-GRP)# end-group
```



```
RP/0/RP0/CPU0:router(config)# apply-group g-logging
```

When this configuration is committed, all commands contained in the g-logging configuration group are committed.

Configuration Group Applied to Different Places: Example

Configuration groups can be applied to different places, and their effect depends on the context within which they are applied. Consider this configuration group:

```
RP/0/RP0/CPU0:router(config)# group g-interfaces
RP/0/RP0/CPU0:router(config-GRP)# interface 'GigabitEthernet.*'
RP/0/RP0/CPU0:router(config-GRP-if)# mtu 1500
RP/0/RP0/CPU0:router(config-GRP-if)# exit
RP/0/RP0/CPU0:router(config-GRP)# interface 'GigabitEthernet.*'
RP/0/RP0/CPU0:router(config-GRP-if)# mtu 1000
RP/0/RP0/CPU0:router(config-GRP-if)# exit
RP/0/RP0/CPU0:router(config-GRP)# interface 'GigabitEthernet.*'
RP/0/RP0/CPU0:router(config-GRP-if)# mtu 2000
RP/0/RP0/CPU0:router(config-GRP-if)# end-group
```

This group can be applied to Gigabit Ethernet interface and in each instance the applicable MTU is applied. For instance, in this example, the Gigabit Ethernet interface is configured to have an MTU of 1000:

```
RP/0/RP0/CPU0:router(config)# interface GigabitEthernet0/2/0/0
RP/0/RP0/CPU0:router(config-if)# apply-group g-interfaces
RP/0/RP0/CPU0:router(config-if)# ipv4 address 2.2.2.2 255.255.255.0
```

In this example, the Gigabit Ethernet interface is configured to have an MTU of 1500:

```
RP/0/RP0/CPU0:router(config)# interface GigabitEthernet0/2/0/0
RP/0/RP0/CPU0:router(config-if)# apply-group g-interfaces
RP/0/RP0/CPU0:router(config-if)# ipv4 address 3.3.3.3 255.255.255.0
```

The same configuration group is used in both cases, but only the applicable configuration statements are used.

Verifying the Configuration of Configuration Groups

Use this task to verify the router configuration using configuration groups:

SUMMARY STEPS

1. **show running-config group** [*group-name*]
2. **show running-config**
3. **show running-config inheritance**

4. show running-config interface x/y/z inheritance *detail*

DETAILED STEPS

	Command or Action	Purpose
Step 1	<p>show running-config group [<i>group-name</i>]</p> <p>Example:</p> <pre>RP/0/RP0/CPU0:router# show running-config group group g-int-ge interface 'GigabitEthernet.*' mtu 1000 negotiation auto ! end-group</pre>	Displays the contents of a specific or all configured configuration groups.
Step 2	<p>show running-config</p> <p>Example:</p> <pre>RP/0/RP0/CPU0:router# show running-config group G-INTERFACE-MTU interface 'GigabitEthernet.*' mtu 1500 ! end-group interface interface GigabitEthernet0/4/1/0 apply-group G-INTERFACE-MTU ! interface interface GigabitEthernet0/4/1/1 apply-group G-INTERFACE-MTU mtu 2000 !</pre>	Displays the running configuration. Any applied groups are displayed. There is no indication as to whether these configuration groups affect the actual configuration or not. In this example, although the group G-INTERFACE-MTU is applied to interface GigabitEthernet0/4/1/1, the configured MTU value is 2000 and not 1500. This happens if the command mtu 2000 is configured directly on the interface. An actual configuration overrides a configuration group configuration if they are the same.
Step 3	<p>show running-config inheritance</p> <p>Example:</p> <pre>RP/0/RP0/CPU0:router# show running-config inheritance . . group G-INTERFACE-MTU interface 'GigabitEthernet.*' mtu 1500 ! end-group . . interface interface GigabitEthernet0/4/1/0 ## Inherited from group G-INTERFACE-MTU mtu 1500 ! interface interface GigabitEthernet0/4/1/1</pre>	Displays the inherited configuration where ever a configuration group has been applied.

	Command or Action	Purpose
	<pre>mtu 2000 !</pre>	
Step 4	<p>show running-config interface x/y/z inheritance detail</p> <p>Example:</p> <pre>RP/0/RP0/CPU0:router# show running-config interface interface GigabitEthernet0/4/1/0 inheritance detail interface interface GigabitEthernet0/4/1/0 ## Inherited from group G-INTERFACE-MTU mtu 1500</pre>	Displays the inherited configuration for a specific configuration command.

Regular Expressions in Configuration Groups

Regular expressions are used in configuration groups to make them widely applicable. Portable Operating System Interface for UNIX (POSIX) 1003.2 regular expressions are supported in the names of configuration statements. Single quotes must be used to delimit a regular expression.



Note Not all POSIX regular expressions are supported.

Regular Expressions for Interface Identifiers

Configuration groups do not accept exact interface identifiers. You must use a regular expression to identify a group of interfaces that are applicable to the configuration group. The regular expression `.*` is not allowed. You must begin the regular expression for an interface identifier with an unambiguous word, followed by the regular expression. For example, to configure Gigabit Ethernet interfaces, use the regular expression `'GigabitEthernet.*'`.

To display a list of available interface types for your router configuration, enter **interface ?** at the configuration group prompt:

```
RP/0/RP0/CPU0:router(config-GRP)# interface ?

ATM                'RegExp': ATM Network Interface(s)
BVI                'RegExp': Bridge-Group Virtual Interface
Bundle-Ether      'RegExp': Aggregated Ethernet interface(s)
GigabitEthernet   'RegExp': GigabitEthernet/IEEE 802.3 interface(s)
IMA               'RegExp': ATM Network Interface(s)
Loopback          'RegExp': Loopback interface(s)
MgmtEth           'RegExp': Ethernet/IEEE 802.3 interface(s)
Multilink         'RegExp': Multilink network interface(s)
Null              'RegExp': Null interface
PW-Ether          'RegExp': PWHE Ethernet Interface
PW-IW             'RegExp': PWHE VC11 IP Interworking Interface
Serial            'RegExp': Serial network interface(s)
tunnel-ip         'RegExp': GRE/IPinIP Tunnel Interface(s)
```

```
tunnel-mte      'RegExp': MPLS Traffic Engineering P2MP Tunnel interface(s)
tunnel-te      'RegExp': MPLS Traffic Engineering Tunnel interface(s)
tunnel-tp      'RegExp': MPLS Transport Protocol Tunnel interface
```



Note Although you are required to enter only enough characters for the interface type to be unique, it is recommended that you enter the entire phrase. All interface types used in regular expressions are case-sensitive.

To specify a subinterface, prefix the expression with the characters \. (backslash period). For example, use `interface 'GigabitEthernet.*\..*'` to configure all Gigabit Ethernet subinterfaces.

You can specify Layer 2 transport interfaces or point-to-point interfaces as shown in these examples:

```
group g-l2t
  interface 'Gi.*\..*' l2transport
  .
end-group
group g-ptp
  interface 'Gi.*\..*' point-to-point
  .
end-group
```

Regular Expressions for an OSPF Configuration

Exact router process names and OSPF areas cannot be used. You must use a regular expression to specify a process name or group of OSPF areas. To specify that the OSPF area can be either a scalar value or an IP address, use the regular expression `'.*'`, as in this example:

```
group g-ospf
  router ospf '.*'
  area '.*'
  mtu-ignore enable
  !
  !
end-group
```

To specify that the OSPF area must be an IP address, use the expression `'\.'` as in this example:

```
group g-ospf-ipaddress
  router ospf '.*\..*\..*\..*.*'
  area '.*'
  passive enable
  !
  !
end-group
```

To specify that the OSPF area must be a scalar value, use the expression `'1.*'`, as in this example:

```
group g-ospf-match-number
  router ospf '.*'
  area '1.*'
  passive enable
```

```
!
!
end-group
```

Regular Expressions for a BGP AS

Exact BGP AS values cannot be used in configuration groups. Use a regular expression to specify either AS plain format, or AS dot format as in the format X.Y. To match AS plain format instances, use a simple regular expression. To match AS dot format instances, use two regular expressions separated by a dot, as shown in this example:

```
group g-bgp
router bgp '*'.'*'
address-family ipv4 unicast
!
!
end-group
```

Regular Expressions for ANCP

Exact Access Node Control Protocol (ANCP) sender-name identifiers cannot be used in configuration groups. Because the sender name argument can be either an IP address or a MAC address, you must specify in the regular expression which one is being used. Specify an IP address as `'.*\..*\..*\..*'`; specify a MAC address as `'.*\..*\..*'`.

Resolving to a Uniform Type

Regular expressions must resolve to a uniform type. This is an example of an illegal regular expression:

```
group g-invalid
interface \.*'
  bundle port-priority 10
!
interface \.*Ethernet.*'
  bundle port-priority 10
!
end-group
```

In this example, the **bundle** command is supported for interface type GigabitEthernet but not for interface type 'FastEthernet'. The regular expressions `'.*'` and `'.*Ethernet.*'` match both GigabitEthernet and FastEthernet types. Because the **bundle** command is not applicable to both these interface types, they do not resolve to a uniform type and therefore the system does not allow this configuration.



Note If the system cannot determine from the regular expression what the configuration should be, the expression is not considered valid.



Note The regular expression `'.*'` is not allowed when referring to an interface identifier. You must begin the regular expression for an interface identifier with an unambiguous word, followed by the regular expression. Refer to *Regular Expressions for Interface Identifiers* in this section for more information.

Overlapping Regular Expressions

Regular expressions are used in names of configuration statements within a configuration group. This permits inheritance by the configuration when applied to matching names. Single quotes are used to delimit the regular expression. Overlapping regular expression within a configuration group for the same configuration is permitted.

The example, given below, illustrates the process of creating and applying multiple configuration groups:

```
RP/0//CPU0:router(config)#group FB_flexi_snmp
RP/0//CPU0:router(config-GRP)# snmp-server vrf '.*'
RP/0//CPU0:router(config-GRP-snmp-vrf)# host 1.1.1.1 traps version 2c group_1
RP/0//CPU0:router(config-GRP-snmp-vrf)# host 1.1.1.1 informs version 2c group_1
RP/0//CPU0:router(config-GRP-snmp-vrf)# context group_1

RP/0//CPU0:router(config-GRP-snmp-vrf)#
RP/0//CPU0:router(config-GRP-snmp-vrf)#commit

RP/0//CPU0:router(config-GRP-snmp-vrf)#root
RP/0//CPU0:router(config)#
RP/0//CPU0:router(config)#snmp-server vrf vrf1
RP/0//CPU0:router(config-snmp-vrf)#snmp-server vrf vrf10
RP/0//CPU0:router(config-snmp-vrf)#!
RP/0//CPU0:router(config-snmp-vrf)#snmp-server vrf vrf100
RP/0//CPU0:router(config-snmp-vrf)#
RP/0//CPU0:router(config-snmp-vrf)#commit

RP/0//CPU0:router(config-snmp-vrf)#root
RP/0//CPU0:router(config)#
RP/0//CPU0:router(config)#apply-group FB_flexi_snmp
RP/0//CPU0:router(config)#do sh running-config group
group FB_flexi_snmp
  snmp-server vrf '.*'
  host 1.1.1.1 traps version 2c group_1
  host 1.1.1.1 informs version 2c group_1
  context group_1
!
end-group
apply-group FB_flexi_snmp
snmp-server vrf vrf1
!
snmp-server vrf vrf10
!
snmp-server vrf vrf100
!
RP/0//CPU0:ios#show running-config inheritance detail

group FB_flexi_snmp
  snmp-server vrf '.*'
  host 1.1.1.1 traps version 2c group_1
  host 1.1.1.1 informs version 2c group_1
  context group_1
!
end-group
snmp-server vrf vrf1
## Inherited from group FB_flexi_snmp
host 1.1.1.1 traps version 2c group_1
## Inherited from group FB_flexi_snmp
host 1.1.1.1 informs version 2c group_1
## Inherited from group FB_flexi_snmp
context group_1
!
```

```

snmp-server vrf vrf10
## Inherited from group FB_flexi_snmp
host 1.1.1.1 traps version 2c group_1
## Inherited from group FB_flexi_snmp
host 1.1.1.1 informs version 2c group_1
## Inherited from group FB_flexi_snmp
context group_1
!
snmp-server vrf vrf100
## Inherited from group FB_flexi_snmp
host 1.1.1.1 traps version 2c group_1
## Inherited from group FB_flexi_snmp
host 1.1.1.1 informs version 2c group_1
## Inherited from group FB_flexi_snmp
context group_1

```

The example given below demonstrates the regular expression. In this example `snmp-server vrf '.*'` and `snmp-server vrf '[\w]+'` are two different regular expressions.

```

group FB_flexi_snmp
snmp-server vrf '.*'
host 1.1.1.1 traps version 2c group_1
host 1.1.1.1 informs version 2c group_1
context group_1
!
snmp-server vrf '[\w]+'
host 2.2.2.2 traps version 2c group_2
host 2.2.2.2 informs version 2c group_2
context group_2
!
end-group

```

This individual regular expression gets combined to all the three expressions - `snmp-server vrf vrf1`, `snmp-server vrf vrf10` and `snmp-server vrf vrf100` as given below.

```

apply-group FB_flexi_snmp
snmp-server vrf vrf1
!
snmp-server vrf vrf10
!
snmp-server vrf vrf100
!

```

In a configuration group, there can be instances of regular expressions overlap. In such cases, the regular expression with the highest priority is activated and inherited, when applied. It has that regular expression, which comes first in the lexicographic order that has the highest priority.

The following example shows how to use overlapping regular expressions and how the expression with higher priority is applied:

```

group FB_flexi_snmp
snmp-server vrf '.*'

```

```

host 1.1.1.1 traps version 2c group_1
host 1.1.1.1 informs version 2c group_1
context group_1
!
snmp-server vrf '[\w]+'
host 2.2.2.2 traps version 2c group_2
host 2.2.2.2 informs version 2c group_2
context group_2
!
end-group

```

The expression shown below has the highest priority:

```

group FB_flexi_snmp
snmp-server vrf '.*'
host 1.1.1.1 traps version 2c group_1
host 1.1.1.1 informs version 2c group_1
context group_1

```

The examples given above, show two different regular expression `snmp-server vrf '.*'` and `snmp-server vrf '[\w]+'`.

The expression below, shows how these two expressions get merged together:

```

apply-group FB_flexi_snmp
snmp-server vrf vrf1
!
snmp-server vrf vrf10
!
snmp-server vrf vrf100
!

```

Any change in a regular expression with lower priority will not affect the inheritance.

Any changes made to an existing regular expression, which is of less (non-top) priority, it will not have any effect on the inheritance.

```

snmp-server vrf '[\w]+'
host 2.2.2.2 traps version 2c group_2
host 2.2.2.2 informs version 2c group_2
context group_2

```

The expression with the higher priority gets inherited, as shown below:

```

group FB_flexi_snmp
snmp-server vrf '.*'

```



```

host 1.1.1.1 traps version 2c group_1

host 1.1.1.1 informs version 2c group_1

context group_1

```

Apply Groups Priority Inheritance

Priority governs inheritance.



Note From the Cisco IOS XR, Release 6.3.1 onwards, you are able to enter the Flexible CLI config group definition, **apply-group** and **exclude-group** command in any order as long as the entire commit has all the group definitions needed.

Apply groups priority inheritance helps flexible configuration groups to handle common configuration statements between groups. When multiple configuration groups have common configuration statements, the inheritance priority is such that the configuration statements present in inner groups have precedence over those configuration statements present in outer groups. In case of tiebreakers, the priority is assigned in accordance to the lexicographical order of regular expressions. User defined order of commands are not accepted.

For example, a configuration statement in configuration group ONE has precedence over another group. A configuration statement in configuration group SEVEN is used only if it does not exist in any other group. Within a configuration group, inheritance priority is the longest match.

```

apply-group SIX SEVEN
router ospf 0
apply-group FOUR FIVE
area 0
apply-group THREE
interface GigabitEthernet0/0/0/0
apply-group ONE TWO

!
!
!

```

The above example shows two scenarios. The inner most group (**apply-group ONE TWO**) has the highest priority. Case 1

The first scenario shows which group gets the priority. The example states which group is applied between different configuration groups (different groups with nothing in common). While applying group one (ONE TWO), all the seven groups matches the interface `interface GigabitEthernet0/0/0/0-` is applied.

Case 2

Here, when all have the same (common) configuration, group one will be active. That is `apply-group ONE TWO` is active. If group ONE is deleted, then group TWO will be active.

Configuration Examples Using Regular Expressions

Configuration Group with Regular Expression: Example

This example shows the definition of a configuration group for configuring Gigabit Ethernet interfaces with ISIS routing parameters, using regular expressions for the exact interface:

```
RP/0/RP0/CPU0:router(config)# group g-isis-gige
RP/0/RP0/CPU0:router(config-GRP)# router isis '.*'
RP/0/RP0/CPU0:router(config-GRP-isis)# interface 'GigabitEthernet.*'
RP/0/RP0/CPU0:router(config-GRP-isis-if)# lsp-interval 20
RP/0/RP0/CPU0:router(config-GRP-isis-if)# hello-interval 40
RP/0/RP0/CPU0:router(config-GRP-isis-if)# address-family ipv4 unicast
RP/0/RP0/CPU0:router(config-GRP-isis-if-af)# metric 10
RP/0/RP0/CPU0:router(config-GRP-isis-if-af)# end-group
RP/0/RP0/CPU0:router(config)#
```

To illustrate the use of this configuration group, assume that you want to configure these Gigabit Ethernet interfaces with the ISIS routing parameters:

```
router isis green
interface GigabitEthernet0/0/0/0
  lsp-interval 20
  hello-interval 40
  address-family ipv4 unicast
  metric 10
!
!
interface GigabitEthernet0/0/0/1
  lsp-interval 20
  hello-interval 40
  address-family ipv4 unicast
  metric 10
!
!
interface GigabitEthernet0/0/0/2
  lsp-interval 20
  hello-interval 40
  address-family ipv4 unicast
  metric 10
!
!
interface GigabitEthernet0/0/0/3
  lsp-interval 20
  hello-interval 40
  address-family ipv4 unicast
  metric 10
!
!
!
```

There are three possible ways to use the configuration group to configure these interfaces. The first is by applying the group within the interface configuration, as shown here:

```
router isis green
interface GigabitEthernet0/0/0/0
  apply-group g-isis-gige
```

```
!  
!  
interface GigabitEthernet0/0/0/1  
    apply-group g-isis-gige  
!  
!  
interface GigabitEthernet0/0/0/2  
    apply-group g-isis-gige  
!  
!  
interface GigabitEthernet0/0/0/3  
    apply-group g-isis-gige  
!  
!
```

In this situation, only the interfaces to which you apply the configuration group inherit the configuration.

The second way to configure these interfaces using the configuration group is to apply the configuration group within the **router isis** configuration, as shown here:

```
router isis green  
    apply-group g-isis-gige  
interface GigabitEthernet0/0/0/0  
!  
interface GigabitEthernet0/0/0/1  
!  
interface GigabitEthernet0/0/0/2  
!  
interface GigabitEthernet0/0/0/3  
!  
!
```

In this way, any other Gigabit Ethernet interfaces that you configure in the ISIS green configuration also inherit these configurations.

The third way to configure these interfaces using the configuration group is to apply the group at the global level as shown here:

```
    apply-group g-isis-gige  
router isis green  
interface GigabitEthernet0/0/0/0  
!  
interface GigabitEthernet0/0/0/1  
!  
interface GigabitEthernet0/0/0/2  
!  
interface GigabitEthernet0/0/0/3  
!  
!
```

In this example, the configuration of the group is applied to all Gigabit Ethernet interfaces configured for ISIS.

Configuration Group Inheritance with Regular Expressions: Example

Local Configuration Has Precedence Over Configuration Group

An explicit configuration takes precedence over a configuration applied from a configuration group. For example, assume that this configuration is running on the router:

```
router ospf 100
  packet-size 1000
!
```

You configure this configuration group, apply it, and commit it to the configuration.

```
RP/0/RP0/CPU0:router(config)# group g-ospf
RP/0/RP0/CPU0:router(config-GRP)# router ospf '.*'
RP/0/RP0/CPU0:router(config-GRP-ospf)# nsf cisco
RP/0/RP0/CPU0:router(config-GRP-ospf)# packet-size 3000
RP/0/RP0/CPU0:router(config-GRP-ospf)# end-group

RP/0/RP0/CPU0:router(config)# apply-group g-ospf
```

The result is effectively this configuration:

```
router ospf 100
  packet-size 1000
  nsf cisco
```

Note that `packet-size 3000` is not inherited from the configuration group because the explicit local configuration has precedence.

Compatible Configuration Is Inherited

The configuration in the configuration group must match the configuration on the router to be inherited. If the configuration does not match, it is not inherited. For example, assume that this configuration is running on the router:

```
router ospf 100
  auto-cost disable
!
```

You configure this configuration and commit it to the configuration.

```
RP/0/RP0/CPU0:router(config)# group g-ospf
RP/0/RP0/CPU0:router(config-GRP)# router ospf '.*'
RP/0/RP0/CPU0:router(config-GRP-ospf)# area '.*'
RP/0/RP0/CPU0:router(config-GRP-ospf-ar)# packet-size 2000
RP/0/RP0/CPU0:router(config-GRP-ospf)# end-group

RP/0/RP0/CPU0:router(config)# apply-group g-ospf

RP/0/RP0/CPU0:router(config)# router ospf 200
RP/0/RP0/CPU0:router(config-ospf)# area 1
```

The result is effectively this configuration:

```
router ospf 100
  auto-cost disable

router ospf 200
  area 1
  packet-size 2000
```

The packet size is inherited by the ospf 200 configuration, but not by the ospf 100 configuration because the area is not configured.

Layer 2 Transport Configuration Group: Example

This example shows how to configure and apply a configuration group with Layer 2 transport subinterfaces:

```
RP/0/RP0/CPU0:router(config)# group g-l2trans-if
RP/0/RP0/CPU0:router(config-GRP)# interface 'TenGigE.*\.*' l2transport
RP/0/RP0/CPU0:router(config-GRP)# mtu 1514
RP/0/RP0/CPU0:router(config-GRP)# end-group

RP/0/RP0/CPU0:router(config)# interface TenGigE0/0/0/0.1 l2transport
RP/0/RP0/CPU0:router(config-if)# apply-group g-l2trans-if
```

When this configuration is committed, the Ten Gigabit Ethernet interface 0/0/0/0.1 inherits the 1514 MTU value. This is the output displayed from the **show running-config inheritance** command for the Ten Gigabit Ethernet interface:

```
interface TenGigE0/0/0/0.1 l2transport
  ## Inherited from group g-l2trans-if
  mtu 1514
  !
```

Configuration Group Precedence: Example

When similar configuration statements are contained in multiple configuration groups, groups applied in inner configuration modes take precedence over groups applied in outer modes. This example shows two configuration groups that configure different cost values for OSPF.

```
RP/0/RP0/CPU0:router(config)# group g-ospf2
RP/0/RP0/CPU0:router(config-GRP)# router ospf '.*'
RP/0/RP0/CPU0:router(config-GRP-ospf)# area '.*'
RP/0/RP0/CPU0:router(config-GRP-ospf-ar)# cost 2
RP/0/RP0/CPU0:router(config-GRP-ospf-ar)# end-group

RP/0/RP0/CPU0:router(config)# group g-ospf100
RP/0/RP0/CPU0:router(config-GRP)# router ospf '.*'
RP/0/RP0/CPU0:router(config-GRP-ospf)# area '.*'
RP/0/RP0/CPU0:router(config-GRP-ospf-ar)# cost 100
RP/0/RP0/CPU0:router(config-GRP-ospf-ar)# end-group
```

If these configuration groups are applied as follows, the cost 2 specified in g-ospf2 is inherited by OSPF area 0 because the group is applied in a more inner configuration mode. In this case, the configuration in group g-ospf100 is ignored.

```
RP/0/RP0/CPU0:router(config)# router ospf 0
RP/0/RP0/CPU0:router(config-ospf)# apply-group g-ospf100
RP/0/RP0/CPU0:router(config-ospf)# area 0
RP/0/RP0/CPU0:router(config-ospf-ar)# apply-group g-ospf2
```

Changes to Configuration Group are Automatically Inherited: Example

When you make changes to a configuration group that is committed and applied to your router configuration, the changes are automatically inherited by the router configuration. For example, assume that this configuration is committed:

```
group g-interface-mtu
  interface 'GigabitEthernet.*'
    mtu 1500
  !
end-group

interface POS0/4/1/0
  apply-group g-interface-mtu
  !
```

Now you change the configuration group as in this example:

```
RP/0/RP0/CPU0:router(config)# group g-interface-mtu
RP/0/RP0/CPU0:router(config-GRP)# interface 'GigabitEthernet.*'
RP/0/RP0/CPU0:router(config-GRP-if)# mtu 2000
RP/0/RP0/CPU0:router(config-GRP-if)# end-group
```

When this configuration group is committed, the MTU configuration for interface GigabitEthernet0/4/1/0 is automatically updated to 2000.

Configuration Examples for Flexible CLI Configuration

Basic Flexible CLI Configuration: Example

This example shows that the Media Access Control (MAC) accounting configuration from the gd21 configuration group is applied to all Gigabit Ethernet interfaces in slot 2, ports 1 to 9.

1. Configure the configuration group that configures MAC accounting:

```
RP/0/RP0/CPU0:router# show running group gd21

group gd21
interface 'GigabitEthernet0/0/0/2[1-9]'
description general interface inheritance check
```

```
load-interval 30
mac-accounting ingress
mac-accounting egress
!
end-group
```

2. Check that the corresponding apply-group is configured in global configuration or somewhere in the hierarchy:

```
RP/0/RP0/CPU0:router# show running | in apply-group gd21

Building configuration...
apply-group gd21
```

3. Check the concise local view of the configuration of some of the interfaces:

```
RP/0/RP0/CPU0:router# show running interface

interface GigabitEthernet0/0/0/21
!
interface GigabitEthernet0/0/0/22
!
```

4. Verify that the match and inheritance occur on these interfaces:

```
RP/0/RP0/CPU0:router# show running-config inheritance interface

interface GigabitEthernet0/0/0/21
## Inherited from group gd21
description general interface inheritance check
## Inherited from group gd21
load-interval 30
## Inherited from group gd21
mac-accounting ingress
## Inherited from group gd21
mac-accounting egress
!
Interface GigabitEthernet0/0/0/22
## Inherited from group gd21
description general interface inheritance check
## Inherited from group gd21
load-interval 30
## Inherited from group gd21
mac-accounting ingress
## Inherited from group gd21
mac-accounting egress
!
!
```

5. Verify that the inherited configuration actually takes effect:

```
RP/0/RP0/CPU0:router# show mac-accounting GigabitEthernet0/0/0/21

GigabitEthernet0/0/0/21
  Input (96 free)
    6c9c.ed35.90fd: 1271 packets, 98426 bytes
    Total: 1271 packets, 98426 bytes
  Output (96 free)
    6c9c.ed35.90fd: 774 packets, 63265 bytes
```

Total: 774 packets, 63264 bytes

Interface MTU Settings for Different Interface Types: Example

This example shows that an MTU value is configured on different interface types.

1. Configure an interface MTU configuration group and apply this group:

```
RP/0/RP0/CPU0:router# show running group l2tr

group l2tr
interface 'GigabitEthernet0/0/0/3.*'
mtu 1500
!
interface 'GigabitEthernet0/0/0/9\..*'
mtu 1400
!
interface 'GigabitEthernet0/0/0/9\..*' l2transport
mtu 1400
!
end-group

RP/0/RP0/CPU0:router# show running | inc apply-group

Building configuration...

apply-group l2tr
```

2. Check the concise view and the inheritance view of the various interfaces:

```
RP/0/RP0/CPU0:router# show running interface gigabitEthernet0/0/0/30

interface GigabitEthernet0/0/0/30
!
RP/0/RP0/CPU0:router# show running interface gigabitEthernet0/0/0/30 inheritance detail

interface GigabitEthernet0/0/0/30
## Inherited from group l2tr
mtu 1500
!

RP/0/RP0/CPU0:router# show running interface gigabitEthernet0/0/0/9.800

interface GigabitEthernet0/0/0/9.800
  encapsulation dot1q 800
!

RP/0/RP0/CPU0:router# show running interface gigabitEthernet0/0/0/9.800 inheritance
detail

interface GigabitEthernet0/0/0/9.800
## Inherited from group l2tr
mtu 1400
encapsulation dot1q800
!

RP/0/RP0/CPU0:router# show running interface gigabitEthernet0/0/0/9.250
```



```
interface GigabitEthernet0/0/0/9.250 l2transport
 encapsulation dot1q 250
!
```

```
RP/0/RP0/CPU0:router# show running interface gigabitEthernet0/0/0/9.800 inheritance
detail
```

```
interface GigabitEthernet0/0/0/9.250 l2transport
 encapsulation dot1q250
## Inherited from group l2tr
 mtu 1400
!
```

3. Verify that the correct values from the group do take effect:

```
RP/0/RP0/CPU0:router# show interface gigabitEthernet 0/0/0/30
```

```
GigabitEthernet0/0/0/30 is down, line protocol is down
Interface state transitions: 0
Hardware is GigabitEthernet, address is 0026.9824.ee56 (bia 0026.9824.ee56)
Internet address is Unknown
MTU 1500 bytes, BW 1000000 Kbit (Max: 1000000 Kbit)
 reliability 255/255, txload 0/255, rxload 0/255
Encapsulation ARPA,
Full-duplex, 1000Mb/s, link type is force-up
output flow control is off, input flow control is off
loopback not set,
Last input never, output never
Last clearing of "show interface" counters never
5 minute input rate 0 bits/sec, 0 packets/sec
5 minute output rate 0 bits/sec, 0 packets/sec
 0 packets input, 0 bytes, 0 total input drops
 0 drops for unrecognized upper-level protocol
Received 0 broadcast packets, 0 multicast packets
 0 runts, 0 giants, 0 throttles, 0 parity
 0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
 0 packets output, 0 bytes, 0 total output drops
Output 0 broadcast packets, 0 multicast packets
 0 output errors, 0 underruns, 0 applique, 0 resets
 0 output buffer failures, 0 output buffers swapped out
```

```
RP/0/RP0/CPU0:router# show interface gigabitEthernet 0/0/0/9.801
```

```
GigabitEthernet0/0/0/9.801 is up, line protocol is up
Interface state transitions: 1
Hardware is VLAN sub-interface(s), address is 0026.9824.ee41
Internet address is Unknown
MTU 1400 bytes, BW 1000000 Kbit (Max: 1000000 Kbit)
 reliability 255/255, txload 0/255, rxload 0/255
Encapsulation 802.1Q Virtual LAN, VLAN Id 801, loopback not set,
Last input never, output never
Last clearing of "show interface" counters never
5 minute input rate 0 bits/sec, 0 packets/sec
5 minute output rate 0 bits/sec, 0 packets/sec
 0 packets input, 0 bytes, 0 total input drops
 0 drops for unrecognized upper-level protocol
Received 0 broadcast packets, 0 multicast packets
 0 packets output, 0 bytes, 0 total output drops
Output 0 broadcast packets, 0 multicast packets
```

```
RP/0/RP0/CPU0:router# show interface gigabitEthernet 0/0/0/9.250

GigabitEthernet0/0/0/9.250 is up, line protocol is up
Interface state transitions: 1
Hardware is VLAN sub-interface(s), address is 0026.9824.ee41
Layer 2 Transport Mode
MTU 1400 bytes, BW 1000000 Kbit (Max: 1000000 Kbit)
  reliability Unknown, txload Unknown, rxload Unknown
Encapsulation 802.1Q Virtual LAN,
  Outer Match: Dot1Q VLAN 250
  Ethertype Any, MAC Match src any, dest any
loopback not set,
Last input never, output never
Last clearing of "show interface" counters never
  0 packets input, 0 bytes
  0 input drops, 0 queue drops, 0 input errors
  0 packets output, 0 bytes

  0 output drops, 0 queue drops, 0 output errors
```

ACL Referencing: Example

This example shows how to reference access-lists on a number of interfaces using configuration groups.

1. Configure the configuration group and apply-group:

```
RP/0/RP0/CPU0:router# show running group acref

group acref
interface 'GigabitEthernet0/0/0/3.*'
  ipv4 access-group adem ingress
  ipv4 access-group adem egress
!
end-group

RP/0/RP0/CPU0:router# show running | inc apply-group

Building configuration...

apply-group isis l2tr isis2 mpp bundle1 acref
```

2. Check the concise and inheritance view of the matching configurations:

```
RP/0/RP0/CPU0:router# show running interface gigabitEthernet 0/0/0/30

interface GigabitEthernet0/0/0/30
!

RP/0/RP0/CPU0:router# show running interface GigabitEthernet 0/0/0/30 inheritance detail

interface GigabitEthernet0/0/0/30
## Inherited from group l2tr
mtu 1500
## Inherited from group acref
ipv4 access-group adem ingress
## Inherited from group acref
```

```

    ipv4 access-group adem egress
    !

RP/0/RP0/CPU0:router# show running interface gigabitEthernet 0/0/0/31

interface GigabitEthernet0/0/0/31
!

RP/0/RP0/CPU0:router# show running interface GigabitEthernet 0/0/0/31 inheritance detail

interface GigabitEthernet0/0/0/31
## Inherited from group l2tr
mtu 1500
## Inherited from group acrest
ipv4 access-group adem ingress
## Inherited from group acrest
ipv4 access-group adem egress

```

3. Check that the ACL group configuration actually got configured by using a traffic generator and watching that denied traffic is dropped.

Local Configuration Takes Precedence: Example

This example illustrates that local configurations take precedence when there is a discrepancy between a local configuration and the configuration inherited from a configuration group.

1. Configure a local configuration in a configuration submode with an access list:

```

RP/0/RP0/CPU0:router# show running interface gigabitEthernet 0/0/0/39

interface GigabitEthernet0/0/0/39
  ipv4 access-group smany ingress
  ipv4 access-group smany egress
!

RP/0/RP0/CPU0:router# show running interface gigabitEthernet 0/0/0/38

interface GigabitEthernet0/0/0/38
!

RP/0/RP0/CPU0:router# show running ipv4 access-list smany

ipv4 access-list smany
  10 permit ipv4 any any
!

RP/0/RP0/CPU0:router# show running ipv4 access-list adem

ipv4 access-list adem
  10 permit ipv4 21.0.0.0 0.255.255.255 host 55.55.55.55
  20 deny ipv4 any any
!

```

2. Configure and apply the access list group configuration:

```

RP/0/RP0/CPU0:router# show running group acrest

group acrest

```

```

interface 'GigabitEthernet0/0/0/3.*'
  ipv4 access-group adem ingress
  ipv4 access-group adem egress
  !
end-group

RP/0/RP0/CPU0:router# show running | inc apply-group

Building configuration...
apply-group isis l2tr isis2 mpp bundle1 acref

```

3. Check the concise and inheritance views for the matching interface where the access list reference is configured locally:

```

RP/0/RP0/CPU0:router# show running interface gigabitEthernet 0/0/0/39

interface GigabitEthernet0/0/0/39
  ipv4 access-group smany ingress
  ipv4 access-group smany egress
  !

RP/0/RP0/CPU0:router# show running interface gigabitEthernet 0/0/0/39 inheritance detail

interface GigabitEthernet0/0/0/39
  ## Inherited from group l2tr
  mtu 1500
  ipv4 access-group smany ingress
  ipv4 access-group smany egress      << no config inherited, local config prioritized
  !

RP/0/RP0/CPU0:router# show running interface gigabitEthernet 0/0/0/38

interface GigabitEthernet0/0/0/38
  !

RP/0/RP0/CPU0:router# show running interface gigabitEthernet 0/0/0/38 inheritance detail

interface GigabitEthernet0/0/0/38
  ## Inherited from group l2tr
  mtu 1500
  ## Inherited from group acref
  ipv4 access-group adem ingress
  ## Inherited from group acref
  ipv4 access-group adem egress
  !

```

4. Use a traffic generator to verify that the traffic pattern for interface GigabitEthernet0/0/0/39 gets acted on by the access list in the local configuration (smany) and not according to the inherited referenced access list (adem).

ISIS Hierarchical Configuration: Example

This example illustrates inheritance and priority handling with two ISIS groups using an ISIS configuration.

1. Configure the local ISIS configuration:

```
RP/0/RP0/CPU0:router# show running router isis
```

```
router isis vink
net 49.0011.2222.2222.2222.00
address-family ipv4 unicast
mpls traffic-eng level-1-2
mpls traffic-eng router-id Loopback0
redistribute connected
!
interface Bundle-Ether1
address-family ipv4 unicast
!
!
interface Bundle-Ether2
!
interface Loopback0
!
interface TenGigE0/2/0/0.3521
address-family ipv4 unicast
!
!
interface TenGigE0/2/0/0.3522
address-family ipv4 unicast
!
!
interface TenGigE0/2/0/0.3523
address-family ipv4 unicast
!
!
interface TenGigE0/2/0/0.3524
address-family ipv4 unicast
!
!
interface TenGigE0/2/0/0.3525
address-family ipv4 unicast
!
!
interface TenGigE0/2/0/0.3526
!
interface TenGigE0/2/0/0.3527
!
interface TenGigE0/2/0/0.3528
!
interface TenGigE0/2/0/1
address-family ipv4 unicast
!
!
!
```

2. Configure two ISIS groups and apply these to the configuration:

```
RP/0/RP0/CPU0:router# show running group isis
```

```
group isis
router isis '.*'
address-family ipv4 unicast
mpls traffic-eng level-1-2
mpls traffic-eng router-id Loopback0
redistribute connected
redistribute ospf 1 level-1-2
!
```

```

interface 'TenGig.*'
  lsp-interval 40
  hello-interval 15
  address-family ipv4 unicast
  metric 50
  !
!
interface 'Bundle-Ether.*'
  address-family ipv4 unicast
  metric 55
  !
!
!
end-group

RP/0/RP0/CPU0:router# show running group isis2

group isis2
router isis '.*'
!
router isis '^(\vink) '
  address-family ipv4 unicast
  !
  interface '^(\Ten)Gig.*'
  !
  interface '^(\Ten)Gig.*'
    address-family ipv4 unicast
    metric 66
  !
!
!
end-group

RP/0/RP0/CPU0:router# show running | inc apply-group

Building configuration...

apply-group isis l2tr isis2 mpp bundle1 ahref

```

3. Check the inheritance view of the ISIS configuration:

```

RP/0/RP0/CPU0:router# show running router isis inheritance detail

router isis vink
net 49.0011.2222.2222.2222.00
address-family ipv4 unicast
  mpls traffic-eng level-1-2
  mpls traffic-eng router-id Loopback0
  redistribute connected
  ## Inherited from group isis
  redistribute ospf 1 level-1-2
!
interface Bundle-Ether1
  address-family ipv4 unicast
  ## Inherited from group isis
  metric 55
!
!
interface Bundle-Ether2
  ## Inherited from group isis
  address-family ipv4 unicast
  ## Inherited from group isis

```

```
metric 55
!
!
interface Loopback0
!
interface TenGigE0/2/0/0.3521
## Inherited from group isis
lsp-interval 40
## Inherited from group isis
hello-interval 15
address-family ipv4 unicast
## Inherited from group isis
metric 50
!
!
interface TenGigE0/2/0/0.3522
## Inherited from group isis
lsp-interval 40
## Inherited from group isis
hello-interval 15
address-family ipv4 unicast
## Inherited from group isis
metric 50
!
!
interface TenGigE0/2/0/0.3523
## Inherited from group isis
lsp-interval 40
## Inherited from group isis
hello-interval 15
address-family ipv4 unicast
## Inherited from group isis
metric 50
!
!
interface TenGigE0/2/0/0.3524
## Inherited from group isis
lsp-interval 40
## Inherited from group isis
hello-interval 15
address-family ipv4 unicast
## Inherited from group isis
metric 50
!
!
interface TenGigE0/2/0/0.3525
## Inherited from group isis
lsp-interval 40
## Inherited from group isis
hello-interval 15
address-family ipv4 unicast
## Inherited from group isis
metric 50
!
!
interface TenGigE0/2/0/0.3526
## Inherited from group isis
lsp-interval 40
## Inherited from group isis
hello-interval 15
## Inherited from group isis
address-family ipv4 unicast
## Inherited from group isis
metric 50
```

```

!
!
interface TenGigE0/2/0/0.3527
  ## Inherited from group isis
  lsp-interval 40
  ## Inherited from group isis
  hello-interval 15
  ## Inherited from group isis
  address-family ipv4 unicast
  ## Inherited from group isis
  metric 50
!
!
interface TenGigE0/2/0/0.3528
  ## Inherited from group isis
  lsp-interval 40
  ## Inherited from group isis
  hello-interval 15
  ## Inherited from group isis
  address-family ipv4 unicast
  ## Inherited from group isis
  metric 50
!
!
interface TenGigE0/2/0/1
  ## Inherited from group isis
  lsp-interval 40
  ## Inherited from group isis
  hello-interval 15
  address-family ipv4 unicast
  ## Inherited from group isis
  metric 50
!
!
!

```

4. Verify the actual functionality:

```

RP/0/RP0/CPU0:router# show isis interface TenGigE0/2/0/0.3528 | inc Metric

Metric (L1/L2):          50/50

```

OSPF Hierarchy: Example

This example illustrates hierarchical inheritance and priority. The configuration that is lower in hierarchy gets the highest priority.

1. Configure a local OSPF configuration:

```

RP/0/RP0/CPU0:router# show running router ospf

router ospf 1
  apply-group go-c
  nsr
  router-id 121.121.121.121
  nsf cisco
  redistribute connected
  address-family ipv4 unicast

```



```

area 0
  apply-group go-b
  interface GigabitEthernet0/0/0/0
    apply-group go-a
  !
  interface GigabitEthernet0/0/0/1
  !
  interface GigabitEthernet0/0/0/3
  !
  interface GigabitEthernet0/0/0/4
  !
  interface GigabitEthernet0/0/0/21
    bfd minimum-interval 100
    bfd fast-detect
    bfd multiplier 3
  !
  interface TenGigE0/2/0/0.3891
  !
  interface TenGigE0/2/0/0.3892
  !
  interface TenGigE0/2/0/0.3893
  !
  interface TenGigE0/2/0/0.3894
  !
!
!
router ospf 100
!
router ospf 1000
!
router ospf 1001
!

```

2. Configure a configuration group and apply it in a configuration submode:

```
RP/0/RP0/CPU0:router# show running group go-a
```

```

group go-a
  router ospf '*'
  area '*'
  interface 'Gig.*'
    cost 200
  !
!
!
end-group

```

```
RP/0/RP0/CPU0:router# show running group go-b
```

```

group go-b
  router ospf '*'
  area '*'
  interface 'Gig.*'
    cost 250
  !
!
!
end-group

```

```
RP/0/RP0/CPU0:router# show running group go-c
```

```

group go-c
  router ospf '*'

```

```

    area '*'
      interface 'Gig.*'
        cost 300
      !
    !
  !
end-group

```

3. Check the inheritance view and verify that the apply-group in the lowest configuration submode gets the highest priority:

```

RP/0/RP0/CPU0:router# show running router ospf 1 inheritance detail

router ospf 1
nsr
router-id 121.121.121.121
nsf cisco
redistribute connected
address-family ipv4 unicast
area 0
  interface GigabitEthernet0/0/0/0
    ## Inherited from group go-a
    cost 200                                << apply-group in lowest submode gets highest priority
  !
  interface GigabitEthernet0/0/0/1
    ## Inherited from group go-b
    cost 250
  !
  interface GigabitEthernet0/0/0/3
    ## Inherited from group go-b
    cost 250
  !
  interface GigabitEthernet0/0/0/4
    ## Inherited from group go-b
    cost 250
  !
  interface GigabitEthernet0/0/0/21
    bfd minimum-interval 100
    bfd fast-detect
    bfd multiplier 3
    ## Inherited from group go-b
    cost 250
  !
  interface TenGigE0/2/0/0.3891
  !
  interface TenGigE0/2/0/0.3892
  !
  interface TenGigE0/2/0/0.3893
  !
  interface TenGigE0/2/0/0.3894
  !
!
!

```

4. Check the functionality of the cost inheritance through the groups:

```

RP/0/RP0/CPU0:router# show ospf 1 interface GigabitEthernet 0/0/0/0

GigabitEthernet0/0/0/0 is up, line protocol is up
  Internet Address 1.0.1.1/30, Area 0
  Process ID 1, Router ID 121.121.121.121, Network Type BROADCAST, Cost: 200

```

```

Transmit Delay is 1 sec, State DR, Priority 1, MTU 1500, MaxPktSz 1500
Designated Router (ID) 121.121.121.121, Interface address 1.0.1.1
No backup designated router on this network
Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
Non-Stop Forwarding (NSF) enabled
  Hello due in 00:00:02
Index 5/5, flood queue length 0
Next 0(0)/0(0)
Last flood scan length is 1, maximum is 40
Last flood scan time is 0 msec, maximum is 7 msec
LS Ack List: current length 0, high water mark 0
Neighbor Count is 1, Adjacent neighbor count is 0
Suppress hello for 0 neighbor(s)
Multi-area interface Count is 0

```

Link Bundling Usage: Example

This example shows how to configure interface membership in a bundle link:

1. Configure the configuration groups:

```

RP/0/RP0/CPU0:router# show running group bundle1

group bundle1
  interface 'GigabitEthernet0/1/0/1[1-6]'
    bundle id 1 mode active
  !
end-group

RP/0/RP0/CPU0:router# show running | inc apply-group

Building configuration...

apply-group isis l2tr isis2 mpp bundle1

```

2. Check the local configuration:

```

RP/0/RP0/CPU0:router# show running interface gigabitEthernet 0/1/0/11

interface GigabitEthernet0/1/0/11
!

RP/0/RP0/CPU0:router# show running interface Bundle-Ether1

interface Bundle-Ether1
  ipv4 address 108.108.1.1 255.255.255.0
  bundle maximum-active links 10
  bundle minimum-active links 5
!

```

3. Check the inheritance configuration view:

```

RP/0/RP0/CPU0:router# show running interface GigabitEthernet 0/1/0/11 inheritance detail

interface GigabitEthernet0/1/0/11

```

```
## Inherited from group bundle1
bundle id 1 mode active
!
```

4. Check that the inheritance configuration took effect:

```
RP/0/RP0/CPU0:router# show interface Bundle-Ether1

Bundle-Ether1 is up, line protocol is up
Interface state transitions: 1
Hardware is Aggregated Ethernet interface(s), address is 0024.f71f.4bc3
Internet address is 108.108.1.1/24
MTU 1514 bytes, BW 6000000 Kbit (Max: 6000000 Kbit)
  reliability 255/255, txload 0/255, rxload 0/255
Encapsulation ARPA,
Full-duplex, 6000Mb/s
loopback not set,
ARP type ARPA, ARP timeout 04:00:00
  No. of members in this bundle: 6
    GigabitEthernet0/1/0/11      Full-duplex 1000Mb/s  Active
    GigabitEthernet0/1/0/12      Full-duplex 1000Mb/s  Active
    GigabitEthernet0/1/0/13      Full-duplex 1000Mb/s  Active
    GigabitEthernet0/1/0/14      Full-duplex 1000Mb/s  Active
    GigabitEthernet0/1/0/15      Full-duplex 1000Mb/s  Active
    GigabitEthernet0/1/0/16      Full-duplex 1000Mb/s  Active
Last input 00:00:00, output 00:00:00
Last clearing of "show interface" counters never
5 minute input rate 8000 bits/sec, 1 packets/sec
5 minute output rate 3000 bits/sec, 1 packets/sec
  2058 packets input, 1999803 bytes, 426 total input drops
  0 drops for unrecognized upper-level protocol
  Received 1 broadcast packets, 2057 multicast packets
    0 runts, 0 giants, 0 throttles, 0 parity
  0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
  1204 packets output, 717972 bytes, 0 total output drops
  Output 2 broadcast packets, 1202 multicast packets
  0 output errors, 0 underruns, 0 applique, 0 resets
  0 output buffer failures, 0 output buffers swapped out
  0 carrier transitions
```



CHAPTER 10

Managing Router Hardware

This chapter describes about clearing the memory and partitions of an RP or a line card before an RMA (Return Merchandise Authorization).

- [Clear the Memory and the Partitions of a Card, on page 119](#)
- [Automatic Fabric Link Shutdown, on page 122](#)
- [System Logs during RSP Switchover, on page 123](#)

Clear the Memory and the Partitions of a Card

Users can clear the memory and the partitions of an RP or a line card before an RMA (Return Merchandise Authorization). Clearing the memory and partitions of the card is performed when the card is defective and has to be returned.

When a line card or an RP is identified for an RMA, the user might want to remove the card from the chassis. However, the service personnel may not be available onsite to remove the card immediately. By clearing the memory and partitions of the card, the users can clear the RP or the line card and power-off the card and also let it remain in the slot.

After clearing the memory, do not reload the card or the chassis until the card is removed from the slot. This is because reloading will reboot the card or the chassis resulting in restoring the data that was erased.

In a dual RP system, the reset of the standby RP must be executed from the active RP. Once the standby RP has been cleaned, the standby RP will be shut down to prevent resync with the active RP.

Prerequisites

XR VM and the System Admin VM must be operational.



Note Do not perform an admin process restart, card reload, or an FPD upgrade while clearing the memory and partitions of the card.

Commands

Run the following commands from the XR VM to clear the memory and the partitions of the card:

- **show zapdisk locations**- displays the locations where the memory and the partition can be cleared.

- **zapdisk start location** <location-id> - clears the memory and the partition from the specified location.

The following steps explain how to clear the memory or the partition of the card:

1. Display the Locations to Clear the Memory - Use the **show zapdisk locations** command to display the locations to be cleared.

The following example shows how to display the location:

<! Display the Locations to Clear the Memory !>

```
Router# show zapdisk locations
0/RP1      Fully qualified location specification
0/2        Fully qualified location specification
0/6        Fully qualified location specification
all        all locations
```

```
Router#conf t
Router(config)#logging console disable
Router(config)#commit
Router(config)#end
```

2. Clear the Memory or Partition - Use the **zapdisk start location** command to clear the memory or partition.

The following example shows how to clear the memory or partition:

<! Clear the Memory or Partition !>

```
Router#zapdisk start location 0/2
Action on designated location is in progress, please monitor admin syslog.
Action on designated location is in progress, please monitor admin syslog.
```

```
Router#zapdisk start location 0/6
Action on designated location is in progress, please monitor admin syslog.
Action on designated location is in progress, please monitor admin syslog.
```

```
Router#zapdisk start location 0/RP1
Action on designated location is in progress, please monitor admin syslog.
Action on designated location is in progress, please monitor admin syslog.
```

3. Verify that the memory and the partition is cleared - Use **show logging**, **show platform**, **show controller card**, and **show reboot-history card location** commands to verify if the memory and partitions are cleared.

The following example shows how to verify if the memory and partitions are successfully cleared:

<!Verification!>

```
sysadmin-vm:0_RP0# show controller card-mgr event-history brief location 0/2
```

```
Card Event History for: 0/2
```

```
Card Event History as seen by Master (0/RP0)
```

```
Current State: ZAPDISK_POWERED_ON
```

DATE	TIME (UTC)	STATE	EVENT
03/04	22:26:13.400	ZAPDISK_RESET	ev_dml_power_up_ok
03/04	22:26:02.630	SYSADMIN_VM_GOING_DOWN	ev_zapdisk_req
03/04	22:25:46.660	CARD_READY	ev_sysadmin_vm_shutdown
03/04	21:58:14.842	OIR_INSERT_NOTIF	if_card_local_init_done
03/04	21:58:14.841	WAIT_CARD_INFO	ev_card_info_synced

```

03/04 21:57:57.219 WAIT_SYSADMIN_VM_READY ev_sysadmin_vm_booted
03/04 21:57:45.305 HOST_OS_RUNNING ev_sysadmin_vm_started
03/04 21:57:24.371 BOOTLDR_STARTED ev_host_os_started
03/04 21:56:04.619 CARD_POWERED_ON ev_bootldr_started
03/04 21:55:58.212 CARD_IN_RESET ev_dml_power_up_ok
03/04 21:55:45.397 IMAGE_INSTALLED ev_ios_install_reset
03/04 21:55:44.896 INSTALLING_IMAGE ev_ios_install_done
03/04 21:54:53.045 WAIT_FIRST_EVENT ev_ios_install_started
03/04 21:54:53.043 IDLE ev_present
    
```

```

sysadmin-vm:0_RP0# show controller card-mgr event-history brief location 0/6
Card Event History for: 0/6
    
```

```

Card Event History as seen by Master (0/RP0)
Current State: ZAPDISK_POWERED_ON
    
```

DATE	TIME (UTC)	STATE	EVENT
03/04	22:26:14.309	ZAPDISK_RESET	ev_dml_power_up_ok
03/04	22:26:03.722	SYSADMIN_VM_GOING_DOWN	ev_zapdisk_req
03/04	22:25:49.563	CARD_READY	ev_sysadmin_vm_shutdown
03/04	22:00:32.071	OIR_INSERT_NOTIF	if_card_local_init_done
03/04	22:00:32.070	WAIT_CARD_INFO	ev_card_info_synced
03/04	22:00:10.314	WAIT_SYSADMIN_VM_READY	ev_sysadmin_vm_booted
03/04	21:59:57.999	HOST_OS_RUNNING	ev_sysadmin_vm_started
03/04	21:59:35.271	BOOTLDR_STARTED	ev_host_os_started
03/04	21:58:18.244	CARD_POWERED_ON	ev_bootldr_started
03/04	21:58:11.836	CARD_IN_RESET	ev_dml_power_up_ok
03/04	21:57:59.122	IMAGE_INSTALLED	ev_ios_install_reset
03/04	21:57:58.521	INSTALLING_IMAGE	ev_ios_install_done
03/04	21:54:53.045	WAIT_FIRST_EVENT	ev_ios_install_started
03/04	21:54:53.043	IDLE	ev_present

```

Aborted: by user
sysadmin-vm:0_RP0# show controller card-mgr event-history brief location 0/RP1
Card Event History for: 0/RP1
    
```

```

Card Event History as seen by Master (0/RP0)
Current State: ZAPDISK_POWERED_ON
    
```

DATE	TIME (UTC)	STATE	EVENT
03/04	22:26:24.730	ZAPDISK_RESET	ev_dml_power_up_ok
03/04	22:26:04.503	HOST_GOING_DOWN	ev_zapdisk_req
03/04	22:26:00.677	SYSADMIN_VM_GOING_DOWN	ev_host_shutdown_started
03/04	22:25:54.770	CARD_READY	ev_sysadmin_vm_shutdown
03/04	21:57:28.878	OIR_INSERT_NOTIF	if_card_local_init_done
03/04	21:57:28.878	WAIT_CARD_INFO	ev_card_info_synced
03/04	21:57:11.443	WAIT_SYSADMIN_VM_READY	ev_sysadmin_vm_booted
03/04	21:56:59.228	HOST_OS_RUNNING	ev_sysadmin_vm_started
03/04	21:56:31.882	BOOTING_IOS_IMAGE	ev_host_os_started
03/04	21:56:26.466	BOOTING_IOS_IMAGE	ev_boot_kernel
03/04	21:56:12.834	CARD_POWERED_ON	ev_bootldr_ssd_boot
03/04	21:56:09.730	CARD_IN_RESET	ev_dml_power_up_ok
03/04	21:55:48.701	IMAGE_INSTALLED	ev_ios_install_reset
03/04	21:55:47.700	INSTALLING_IMAGE	ev_ios_install_done
03/04	21:54:53.046	WAIT_FIRST_EVENT	ev_ios_install_started

```

Aborted: by user
sysadmin-vm:0_RP0# show logging | i card_mgr
0/RP0/ADMIN0:Mar 4 22:26:03.240 : card_mgr[3211]: %DRIVER-CARD_MGR-5-ZAPDISK_STARTED :
Card cleanup started for location 0/2
0/RP0/ADMIN0:Mar 4 22:26:04.332 : card_mgr[3211]: %DRIVER-CARD_MGR-5-ZAPDISK_STARTED :
Card cleanup started for location 0/6
0/RP0/ADMIN0:Mar 4 22:26:04.503 : card_mgr[3211]: %DRIVER-CARD_MGR-5-ZAPDISK_STARTED :
    
```

```

Card cleanup started for location 0/RP1
sysadmin-vm:0_RP0# show reboot-history card location 0/2
Card Reboot History for 0/2
0
Reason Code 22
Reason      "ZAPDISK by user request"
Src Location 0/RP0
Src Name    card_mgr
sysadmin-vm:0_RP0# show reboot-history card location 0/6

Card Reboot History for 0/6
0
Reason Code 22
Reason      "ZAPDISK by user request"
Src Location 0/RP0
Src Name    card_mgr
sysadmin-vm:0_RP0# show reboot-history card location 0/RP1
Card Reboot History for 0/RP1
0
Reason Code 22
Reason      "ZAPDISK by user request"
Src Location 0/RP0
Src Name    card_mgr

sysadmin-vm:0_RP0# show reboot-history card location 0/RP1
Card Reboot History for 0/RP1
0
Reason Code 22
Reason      "ZAPDISK by user request"
Src Location 0/RP0
Src Name    card_mgr

```

4. Power-Down the Card - Shut down the card.

Automatic Fabric Link Shutdown

Table 7: Feature History Table

Feature Name	Release Information	Feature Description
Automatic Fabric Link Shutdown	Release 7.4.1	If a fabric link goes down 30 times in 24 hours, this feature automatically shuts down the faulty fabric link. In doing so, any traffic blackholes that lead to traffic losses are avoided.

This feature enables automatic shutdown of faulty fabric link that experiences excessive flapping. The shutdown is triggered if a fabric link flaps for more than 30 times within 24 hours. With the faulty link being shut down, the traffic moves to a stable link avoiding any traffic disruption.

An error message on the console and a syslog entry captures the fault details for further troubleshooting.

```
0/FC5/ADMIN0:May 24 23:20:58.460 UTC: sfe_driver[7560]: %FABRIC-SFE_DRV-4-LINK_SHUT :
[7560] : link 0/FC5/0/137 is too noisy and will be shut down
```

This feature is supported on:

- All Cisco NCS 5500 series modular routers

- NCS-55A1-36H-SE, NCS-55A1-36H-S, NCS-5502-SE, and NCS-5502 fixed port routers

To recover the faulty fabric link:

- Reboot the fabric card in modular routers
- Reboot the fixed port routers

If there's traffic drop even after reboot, contact Cisco Technical Support.

System Logs during RSP Switchover

Table 8: Feature History Table

Feature Name	Release Information	Feature Description
RSP Slot Location in Syslog	Release 7.8.1	<p>When an RSP switchover occurs, the router logs the active RSP slot location in the syslog message. This helps you quickly identify the active RSP slot from your router's system log messages.</p> <p>In earlier releases, the RSP switchover Syslog message didn't include the active RSP slot location.</p>

In the event of an RSP switchover, the router logs the following syslog messages:

```
RP/0/1/CPU0:Feb 19 09:08:00.655 UTC: rmf_svr[436]: %HA-REDCON-6-GO_ACTIVE : this card going active
RP/1/1/CPU0:Mar 8 11:43:29.041 UTC: rmf_svr[147]: %HA-REDCON-6-GO_STANDBY : this card going standby, location RP/1/1/CPU0
```

From Cisco IOS XR Release 7.8.1 onwards, the RSP switchover syslog message for the active RSP includes the RSP slot location as well:

```
RP/0/1/CPU0:Mar 8 11:42:50.876 UTC: rmf_svr[165]: %HA-REDCON-6-GO_ACTIVE : this card going active , location RP/0/1/CPU0:
```




CHAPTER 11

Configuring Network Time Protocol

Network Time Protocol (NTP) is a protocol designed to time-synchronize devices within a network. Cisco IOS XR software implements NTPv4. NTPv4 retains backwards compatibility with the older versions of NTP, including NTPv3 and NTPv2 but excluding NTPv1, which has been discontinued due to security vulnerabilities.

- [Prerequisites for Implementing NTP on Cisco IOS XR Software, on page 125](#)
- [Information About Implementing NTP, on page 125](#)
- [Configuration Examples for Implementing NTP, on page 144](#)
- [Configuring NTP server inside VRF interface, on page 147](#)

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.

The Cisco implementation of NTP supports three ways that a networking device can obtain NTP time information on a network:

- By polling host servers
- By listening to NTP broadcasts
- By listening to NTP multicasts
- By using a peer-to-peer relationship.

In a LAN environment, NTP can be configured to use IP broadcast or multicast messages. As compared to polling, IP broadcast or multicast 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.

An NTP multicast server periodically sends a message to a designated IPv4 or IPv6 local multicast group address. An NTP multicast client listens on this address for NTP messages.

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.



Note To configure day light saving time (DST) on your IOS XR 64-bit device, select the appropriate country and city. The device will automatically update the DST based on the internal mappings at kernel level. The `DST` keyword is not available in the configuration CLI, since manual configuration of DST is not supported on IOS XR 64-bit devices.

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.

SUMMARY STEPS

1. **configure**
2. **ntp**
3. **server** *ip-address* [**vrf** *vrf*] [**version** *number*] [**key** *key-id*] [**minpoll** *interval*] [**maxpoll** *interval*] [**source** *type interface-path-id*] [**prefer**] [**burst**] [**iburst**]
4. **peer** *ip-address* [**vrf** *vrf*] [**version** *number*] [**key** *key-id*] [**minpoll** *interval*] [**maxpoll** *interval*] [**source** *type interface-path-id*] [**prefer**]
5. Use one of the following commands:
 - **end**
 - **commit**

DETAILED STEPS

	Command or Action	Purpose
Step 1	configure Example: RP/0/RP0/CPU0:router# <code>configure</code>	Enters global configuration mode.
Step 2	ntp Example: RP/0/RP0/CPU0:router(config)# <code>ntp</code>	Enters NTP configuration mode.
Step 3	server <i>ip-address</i> [vrf <i>vrf</i>] [version <i>number</i>] [key <i>key-id</i>] [minpoll <i>interval</i>] [maxpoll <i>interval</i>] [source <i>type interface-path-id</i>] [prefer] [burst] [iburst] Example:	Forms a server association with another system. This step can be repeated as necessary to form associations with multiple devices.

	Command or Action	Purpose
	RP/0/RP0/CPU0:router(config-ntp)# server 172.16.22.44	
Step 4	<p>peer <i>ip-address</i> [vrf <i>vrf</i>] [version <i>number</i>] [key <i>key-id</i>] [minpoll <i>interval</i>] [maxpoll <i>interval</i>] [source <i>type</i> <i>interface-path-id</i>] [prefer]</p> <p>Example:</p> <pre>RP/0/RP0/CPU0:router(config-ntp)# peer 192.168.22.33 source tengige 0/0/0/1</pre>	<p>Forms a peer association with another system. This step can be repeated as necessary to form associations with multiple systems.</p> <p>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.</p>
Step 5	<p>Use one of the following commands:</p> <ul style="list-style-type: none"> • end • commit <p>Example:</p> <pre>RP/0/RP0/CPU0:router(config-ntp)# end</pre> <p>or</p> <pre>RP/0/RP0/CPU0:router(config-ntp)# commit</pre>	<p>Saves configuration changes.</p> <ul style="list-style-type: none"> • When you issue the end command, the system prompts you to commit changes: <pre>Uncommitted changes found, commit them before exiting(yes/no/cancel)? [cancel]:</pre> <ul style="list-style-type: none"> • 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.

SUMMARY STEPS

1. **configure**
2. **ntp**
3. (Optional) **broadcastdelay** *microseconds*
4. **interface** *type interface-path-id*
5. **broadcast client**
6. **broadcast** [**destination** *ip-address*] [**key** *key-id*] [**version** *number*]
7. 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 global configuration mode.
Step 2	ntp Example: RP/0/RP0/CPU0:router(config)# ntp	Enters NTP configuration mode.
Step 3	(Optional) broadcastdelay <i>microseconds</i> Example: RP/0/RP0/CPU0:router(config-ntp)# broadcastdelay 5000	Adjusts the estimated round-trip delay for NTP broadcasts.
Step 4	interface <i>type interface-path-id</i> Example: RP/0/RP0/CPU0:router(config-ntp)# interface POS 0/1/0/0	Enters NTP interface configuration mode.

	Command or Action	Purpose
Step 5	broadcast client Example: <pre>RP/0/RP0/CPU0:router(config-ntp-int)# broadcast client</pre>	Configures the specified interface to receive NTP broadcast packets. Note Go to the next step to configure the interface to send NTP broadcast packets.
Step 6	broadcast [destination ip-address] [key key-id] [version number] Example: <pre>RP/0/RP0/CPU0:router(config-ntp-int)# broadcast destination 10.50.32.149</pre>	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: <ul style="list-style-type: none"> • end • commit Example: <pre>RP/0/RP0/CPU0:router(config-ntp-int)# end</pre> or <pre>RP/0/RP0/CPU0:router(config-ntp-int)# commit</pre>	Saves configuration changes. <ul style="list-style-type: none"> • When you issue the end command, the system prompts you to commit changes: <pre>Uncommitted changes found, commit them before exiting(yes/no/cancel)? [cancel]:</pre> <ul style="list-style-type: none"> • 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. NTP communication consists of time requests and control queries. A *time request* is a request for time synchronization from an NTP server. A *control query* is a request for configuration information from an NTP server.

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).

SUMMARY STEPS

1. **configure**
2. **ntp**
3. **access-group** {**peer** | **query-only** | **serve** | **serve-only**} *access-list-name*
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 global configuration 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 } <i>access-list-name</i> 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: <ul style="list-style-type: none"> • end • commit Example: RP/0/RP0/CPU0:router (config-ntp)# end	Saves configuration changes. <ul style="list-style-type: none"> • When you issue the end command, the system prompts you to commit changes: <pre>Uncommitted changes found, commit them before</pre>

	Command or Action	Purpose
	or <pre>RP/0/RP0/CPU0:router(config-ntp)# commit</pre>	<pre> exiting (yes/no/cancel)? [cancel]:</pre> <ul style="list-style-type: none"> • 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. <ul style="list-style-type: none"> • 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.



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

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.

SUMMARY STEPS

1. **configure**
2. **ntp**
3. **authenticate**
4. **authentication-key** *key-number* **md5** [**clear** | **encrypted**] *key-name*
5. **trusted-key** *key-number*

6. 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 global configuration 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 <i>key-number</i> md5 [clear encrypted] <i>key-name</i> Example: RP/0/RP0/CPU0:router(config-ntp)# authentication-key 42 md5 clear key1	Defines the authentication keys. <ul style="list-style-type: none"> • Each key has a key number, a type, a value, and, a name. Currently the only key type supported is md5.
Step 5	trusted-key <i>key-number</i> Example: RP/0/RP0/CPU0:router(config-ntp)# trusted-key 42	Defines trusted authentication keys. <ul style="list-style-type: none"> • 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: <ul style="list-style-type: none"> • end • commit Example: RP/0/RP0/CPU0:router(config-ntp)# end or RP/0/RP0/CPU0:router(config-ntp)# commit	Saves configuration changes. <ul style="list-style-type: none"> • When you issue the end command, the system prompts you to commit changes: <pre>Uncommitted changes found, commit them before exiting(yes/no/cancel)? [cancel]:</pre> • Entering yes saves configuration changes to the running configuration file, exits the configuration session, and returns the router to EXEC mode.

	Command or Action	Purpose
		<ul style="list-style-type: none"> • 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.

SUMMARY STEPS

1. **configure**
2. **ntp**
3. Use one of the following commands:
 - **no interface** *type interface-path-id*
 - **interface** *type interface-path-id* **disable**
4. Use one of the following commands:
 - **end**
 - **commit**

DETAILED STEPS

	Command or Action	Purpose
Step 1	configure Example: RP/0/RP0/CPU0:router# <code>configure</code>	Enters global configuration mode.
Step 2	ntp Example: RP/0/RP0/CPU0:router(config)# <code>ntp</code>	Enters NTP configuration mode.
Step 3	Use one of the following commands: <ul style="list-style-type: none"> • no interface <i>type interface-path-id</i> 	Disables NTP services on the specified interface.

	Command or Action	Purpose
	<ul style="list-style-type: none"> • <code>interface type interface-path-id disable</code> <p>Example:</p> <pre>RP/0/RP0/CPU0:router(config-ntp)# no interface pos 0/0/0/1</pre> <p>or</p> <pre>RP/0/RP0/CPU0:router(config-ntp)# interface POS 0/0/0/1 disable</pre>	
Step 4	<p>Use one of the following commands:</p> <ul style="list-style-type: none"> • <code>end</code> • <code>commit</code> <p>Example:</p> <pre>RP/0/RP0/CPU0:router(config-ntp)# end</pre> <p>or</p> <pre>RP/0/RP0/CPU0:router(config-ntp)# commit</pre>	<p>Saves configuration changes.</p> <ul style="list-style-type: none"> • When you issue the end command, the system prompts you to commit changes: <pre>Uncommitted changes found, commit them before exiting(yes/no/cancel)? [cancel]:</pre> <ul style="list-style-type: none"> • 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. <ul style="list-style-type: none"> • 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.



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

SUMMARY STEPS

1. `configure`
2. `ntp`

3. `source type interface-path-id`
4. Use one of the following commands:
 - `end`
 - `commit`

DETAILED STEPS

	Command or Action	Purpose
Step 1	<p>configure</p> <p>Example:</p> <pre>RP/0/RP0/CPU0:router# configure</pre>	Enters global configuration mode.
Step 2	<p>ntp</p> <p>Example:</p> <pre>RP/0/RP0/CPU0:router(config)# ntp</pre>	Enters NTP configuration mode.
Step 3	<p>source type interface-path-id</p> <p>Example:</p> <pre>RP/0/RP0/CPU0:router(config-ntp)# source POS 0/0/0/1</pre>	<p>Configures an interface from which the IP source address is taken.</p> <p>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 127.</p>
Step 4	<p>Use one of the following commands:</p> <ul style="list-style-type: none"> • <code>end</code> • <code>commit</code> <p>Example:</p> <pre>RP/0/RP0/CPU0:router(config-ntp)# end</pre> <p>or</p> <pre>RP/0/RP0/CPU0:router(config-ntp)# commit</pre>	<p>Saves configuration changes.</p> <ul style="list-style-type: none"> • When you issue the end command, the system prompts you to commit changes: <pre>Uncommitted changes found, commit them before exiting (yes/no/cancel)? [cancel]:</pre> <ul style="list-style-type: none"> • 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.

	Command or Action	Purpose
		<ul style="list-style-type: none"> 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.



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

SUMMARY STEPS

1. **configure**
2. **ntp**
3. **master** *stratum*
4. Use one of the following commands:
 - **end**
 - **commit**

DETAILED STEPS

	Command or Action	Purpose
Step 1	configure Example: RP/0/RP0/CPU0:router# <code>configure</code>	Enters global configuration mode.
Step 2	ntp Example: RP/0/RP0/CPU0:router(config)# <code>ntp</code>	Enters NTP configuration mode.
Step 3	master <i>stratum</i> Example: RP/0/RP0/CPU0:router(config-ntp)# <code>master 9</code>	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.

	Command or Action	Purpose
Step 4	<p>Use one of the following commands:</p> <ul style="list-style-type: none"> • end • commit <p>Example:</p> <pre>RP/0/RP0/CPU0:router(config-ntp)# end</pre> <p>or</p> <pre>RP/0/RP0/CPU0:router(config-ntp)# commit</pre>	<p>Saves configuration changes.</p> <ul style="list-style-type: none"> • When you issue the end command, the system prompts you to commit changes: <pre>Uncommitted changes found, commit them before exiting (yes/no/cancel)? [cancel]:</pre> <ul style="list-style-type: none"> • 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.

FQDN for NTP Server

Table 9: Feature History Table

Feature Name	Release Information	Feature Description
FQDN for NTP Server on Non-default VRF	Release 7.9.1	<p>You can now specify a Fully Qualified Domain Name (FQDN) as the hostname for NTP server configuration over non-default VRFs.</p> <p>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.</p> <p>Prior releases allowed FQDN handling in only default VRFs.</p>

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

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 Default VRF

Use the **ntp server** command with the FQDN name to configure FQDN on default VRF. You don't 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
```



Note When you are configuring FQDN over default VRF, you don't need to specify VRF name.

Running Configuration

Use the **show running-config ntp** command to see the ntp running configuration.

```
Router#show running-config ntp
ntp
 server 10.48.59.212
!
```

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
~10.48.59.212         173.38.201.67  2   42   128   3  196.06 -14.25 3949.4
* sys_peer, # selected, + candidate, - outlayer, x falseticker, ~ configured
```

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 pingable, you can configure FQDN to be used as an NTP server/peer. The following example shows how to configure an NTP server using its FQDN over a nondefault vrf.

```
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
```

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.



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

SUMMARY STEPS

1. **configure**
2. **ntp**
3. **update-calendar**
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 global configuration 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 to update its system calendar from the software clock at periodic intervals.
Step 4	Use one of the following commands: <ul style="list-style-type: none"> • end • commit Example: RP/0/RP0/CPU0:router(config-ntp)# end or RP/0/RP0/CPU0:router(config-ntp)# commit	Saves configuration changes. <ul style="list-style-type: none"> • 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.

SUMMARY STEPS

1. `show ntp associations [detail] [location node-id]`
2. `show ntp status [location node-id]`

DETAILED STEPS

	Command or Action	Purpose
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.

Examples

The following is sample output from the `show ntp associations` command:

```
RP/0/RP0/CPU0:router# show ntp associations
Tue Oct  7 11:22:46.839 JST

      address          ref clock      st  when  poll reach  delay  offset  disp
*~192.168.128.5      10.81.254.131  2   1    64  377   7.98  -0.560  0.108
+~dead:beef::2 vrf testAA
                    171.68.10.80   3   20   64  377   6.00  -2.832  0.046
* sys_peer, # selected, + candidate, - outlayer, x falseticker, ~ configured

RP/0/RP0/CPU0:router# show ntp associations

      address          ref clock      st  when  poll reach  delay  offset  disp
+~127.127.1.1        127.127.1.1   5   5    1024  37   0.0   0.00   438.3
*~172.19.69.1        172.24.114.33  3   13  1024   1   2.0   67.16  0.0
* master (syncd), # master (unsyncd), + selected, - candidate, ~ configured
```

The following is sample output from the `show ntp status` command:

```
RP/0/RP0/CPU0:router# show ntp status
Tue Oct  7 11:22:54.023 JST

Clock is synchronized, stratum 3, reference is 192.168.128.5
nominal freq is 1000.0000 Hz, actual freq is 1000.2725 Hz, precision is 2**24
reference time is CC95463C.9B964367 (11:21:48.607 JST Tue Oct  7 2008)
clock offset is -1.738 msec, root delay is 186.050 msec
root dispersion is 53.86 msec, peer dispersion is 0.09 msec
loopfilter state is 'CTRL' (Normal Controlled Loop), drift is -0.0002724105 s/s
system poll interval is 64, last update was 66 sec ago
```

```
RP/0/RP0/CPU0:router# show ntp status

Clock is synchronized, stratum 4, reference is 172.19.69.1
nominal freq is 1000.0000 Hz, actual freq is 999.9988 Hz, precision is 2**26
reference time is C54C131B.9EECF6CA (07:26:19.620 UTC Mon Nov 24 2008)
clock offset is 66.3685 msec, root delay is 7.80 msec
root dispersion is 950.04 msec, peer dispersion is 3.38 msec
```

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
 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 tengige 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 tengige 0/2/0/2
   broadcast
```

Configuring Multicast-Based Associations: Example

The following example shows an NTP multicast client configuration where 10-Gigabit Ethernet interface 0/1/1/0 is configured to be a multicast client and to join the default multicast group (IPv4 address 224.0.1.1):

```
ntp interface TenGigE 0/1/1/0
  multicast client
```

The following example shows an NTP multicast server configuration where 10-Gigabit Ethernet interface 0/1/1/0 is configured to be a multicast server:

```
ntp interface TenGigE 0/1/1/0
  multicast destination 224.0.1.1
```

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 tengige 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
```

Configuring NTP server inside VRF interface

This task explains how to configure NTP server inside VRF interface.



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

SUMMARY STEPS

1. **configure**
2. **ntp**
3. **vrf** *vrf-name*
4. **source** *interface-type interface-instance*
5. Use one of the following commands:
 - **end**
 - **commit**

DETAILED STEPS

	Command or Action	Purpose
Step 1	configure Example:	Enters global configuration mode.

	Command or Action	Purpose
	RP/0/RP0/CPU0:router# configure	
Step 2	<p>ntp</p> <p>Example:</p> <pre>RP/0/RP0/CPU0:router(config)# ntp</pre>	Enters NTP configuration mode.
Step 3	<p>vrf vrf-name</p> <p>Example:</p> <pre>RP/0/RP0/CPU0:router(config)# ntp vrf Customer_A</pre>	Specify name of a VRF (VPN- routing and forwarding) instance to configure.
Step 4	<p>source interface-type interface-instance</p> <p>Example:</p> <pre>RP/0/RP0/CPU0:router(config)# ntp vrf Customer_A source bvi 70</pre>	<p>Configures an interface from which the IP source address is taken. This allows IOS-XR to respond to NTP queries on VRF interfaces, in this case the source is BVI.</p> <p>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 127.</p>
Step 5	<p>Use one of the following commands:</p> <ul style="list-style-type: none"> • end • commit <p>Example:</p> <pre>RP/0/RP0/CPU0:router(config-ntp)# end</pre> <p>or</p> <pre>RP/0/RP0/CPU0:router(config-ntp)# commit</pre>	<p>Saves configuration changes.</p> <ul style="list-style-type: none"> • When you issue the end command, the system prompts you to commit changes: <pre>Uncommitted changes found, commit them before exiting(yes/no/cancel)? [cancel]:</pre> <ul style="list-style-type: none"> • 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.



CHAPTER 12

Configuring Precision Time Protocol

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.

This module contains the following topics:

- [PTP Overview, on page 149](#)
- [ITU-T Telecom Profiles for PTP, on page 162](#)
- [PTP Holdover Traceability Suppression, on page 171](#)
- [Configuring PTP, on page 172](#)
- [Configuration Examples, on page 183](#)

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 10: 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.

Network Element	Description
Ordinary Clock (OC)	<p>An ordinary clock is a 1588 clock with a single PTP port that can operate in one of the following modes:</p> <ul style="list-style-type: none"> • 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)	<p>The device participates in selecting the best master clock and can act as the master clock if no better clocks are detected.</p> <p>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.</p>
Transparent Clock (TC)	<p>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.</p>

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-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 [Configuring PTP Hybrid Mode](#) is described in a subsequent section in this chapter.

Time of Day (ToD) Support

The router receives GPS ToD messages in serial ASCII stream through the RS422 interface in any of the following formats:

- NTP Type 4
- Cisco
- NMEA - GPZDA



Note You can refer to the below support information in context of the current release and see relevant *Release Notes* for more information on supported features and hardware.

Port States

State machine indicates the behavior of each port. The possible states are:

State	Description
INIT	Port is not ready to participate in PTP.

State	Description
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 NCS 5500 Series Router:

- NCS55-RP does not support PTP
- NC55-18H18F line card does not support PTP
- SyncE is not supported on a 1GE copper SFP.
- SyncE is not supported on 25 GE or 100 GE interfaces when they are used in 1G mode.
- 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 MACSec.
- G.8273.2 Class-A performance is met if CFP2-DCO is configured on either Slave or Master port on the node.
- Transparent Clock is not supported.
- PTP over MPLS is not supported.



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.

PTP Support Information

This table lists different types of support information related to PTP:

Transport Media	<ul style="list-style-type: none"> • UDP over IPv4 • Ethernet
Messages	<ul style="list-style-type: none"> • Signaling • Announce • Sync • Follow-up • Delay-request • Delay-response • Management
Transport Modes	<ul style="list-style-type: none"> • 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.

PTP Hardware Support Matrix



Note The table also contains support details of upcoming releases. You can read this table in context of the current release and see relevant *Release Notes* for more information on supported features and hardware.

This table provides a detailed information on the timing features that are supported on the following hardware variants.

Hardware Variant	Features	Cisco IOS XR Release	Comments
NC57-48Q2D-S NC57-48Q2D-SE-S	G8275.1	Release 7.10.1	<p>With this release, SyncE and PTP Class-C, Class-B performance is supported on 1G, 10G, 25G, 40G and 100G port speeds.</p> <p>On 50G and 400G ports speeds, only timing functionality is supported.</p> <p>PTP support is available on compatible mode.</p> <p>PTP with Class-C is not achieved with macsec on any interface speed.</p> <p>Note For 1G Class C port speed, only port 32 and 40 are supported. It is not recommended to plug in 1G optics to ports greater than or equal to port 32.</p>
NC57-36H6D-S	G8265.1	Release 7.10.1	<p>With this release, timing support for PTP and SyncE is extended to 4x10G and 4x25G breakout ports of NC57-36H6D-S in native mode.</p> <p>Class B and Class C performances are supported on 4x10G and 4x25G breakout ports in native mode. Route Processor: NC55-RP2-E</p>
	G8275.1		
	G8275.2		
	Default Profile		

Hardware Variant	Features	Cisco IOS XR Release	Comments
NC57-36H-SE	G8265.1	Release 7.10.1	<p>With this release, timing support for PTP and SyncE is extended to 4x10G breakout port of NC57-36H-SE is in native mode.</p> <p>Class B performance is supported on 4x10G breakout port in native mode.</p> <p>Route Processor: NC55-RP2-E</p>
	G8275.1		
	G8275.2		
	Default Profile		
NCS-57C1-48Q6-SYS	G.8265.1	Release 7.10.1	<p>G.8273.2 Class C is supported on 400G interfaces with the following optics modules:</p> <ul style="list-style-type: none"> • Cisco QSFPDD 400G FR4 Pluggable Optics Module • Cisco QSFPDD 400G LR4 Pluggable Optics Module
	G.8275.1		
	G.8275.2		
	Default Profile		
G.8275.1	Release 7.8.1		
G.8275.2	Release 7.8.1		
Default Profile	Release 7.8.1		
NCS-57C3-MODS-SYS NCS-57C3-MODS-SYS	PTP Virtual Port and APTS	Release 7.7.1	
NCS-57B1-6D24-SYS	PTP Virtual Port and APTS	Release 7.7.1	
NCS-57C1-48Q6-SYS	Default profile	Release 7.5.1	
	G.8265.1	Release 7.5.1	
	G.8275.1	Release 7.5.1	
	G.8275.2	Release 7.5.1	
RP:NC57-MOD-RP-2E with NCS573-MODS-SYS and NCS-573-MOD-SYS	G.8275.1	Release 7.4.1	
	G.8273.2	Release 7.4.1	
	GNSS	Release 7.4.1	

Hardware Variant	Features	Cisco IOS XR Release	Comments
NCS-57B1-5DSE-SYS	Default profile	Release 7.3.1	
NCS-57B1-6D24-SYS	G.8265.1	Release 7.3.1	
	G.8275.1	Release 7.3.1	
	G.8275.2	Release 7.3.1	
RP: NC55-RP2-E Line card: NC57-36H6D-S	G.8275.1	Release 7.3.2	<ul style="list-style-type: none"> • Release 7.3.2 - Supports Compatible Mode only • Release 7.7.1 - Supports both Native and Compatible mode.
	G.8273.2	Release 7.3.2	<ul style="list-style-type: none"> • Release 7.3.2 - Supports Compatible Mode only • Release 7.7.1 - Supports both Native and Compatible mode.
RP:NC55-RP-E with Line cards: NC55-MOD-A-S and NC55-32T16Q4H-AT	BITS	Release 7.1.1	
	G8275.1	Release 7.1.1	For the profile G8275.1 NC55-32T16Q4H-AT supports only T-BC and does not support T-GM. 25G/100G/40G is supported from IOSXR release 7.2.2 onwards.
	G8273.2	Release 7.1.1	Class B
RP:NC55-RP2-E with Line cards: NC55-MOD-A-S and NC55-32T16Q4H-AT	BITS	Release 7.1.1	
	G.8275.1	Release 7.1.1	For the profile G8275.1 NC55-32T16Q4H-AT supports only T-BC and does not support T-GM. 25G/100G/40G is supported from IOSXR release 7.2.2 onwards.
	G.8273.2	Release 7.1.1	Class B

Hardware Variant	Features	Cisco IOS XR Release	Comments
RP:NC55-RP2-E with Line card:NC55-32T16Q4H-AT	BITS	Release 7.1.1	
	G8275.1	Release 7.1.1	For the profile G8275.1 NC55-32T16Q4H-AT supports only T-BCand does not support T-GM. 25G/100G/40G is supported from IOSXR release 7.2.2 onwards.
	G.8273.2	Release 7.1.1	Class C
NCS-55A1-36H-SE-S	G.8265.1	Release 7.0.1	
	G.8275.1	Release 7.0.1	
	G.8275.2	Release 7.0.1	
	G.8273.2	Release 7.0.1	Class B
NCS-55A1-36H-S	G.8265.1	Release 7.0.1	
	G.8275.1	Release 7.0.1	
	G.8275.2	Release 7.0.1	
	G.8273.2	Release 7.0.1	Class B
NCS-55A1-24Q6H-S NCS-55A1-24Q6H-SS	G.8265.1	Release 6.6.25	
	G.8275.1	Release 6.6.25	
	G.8275.2	Release 6.6.25	From Release 7.7.1, support is available for PTP over IPv6 for ports 10G-25G and 40G-100G
	G.8273.2	Release 6.6.25	Class B
NCS-55A1-48Q6H	G.8265.1	Release 6.6.25	
	G.8275.1	Release 6.6.25	
	G.8275.2	Release 6.6.25	
	G.8273.2	Release 6.6.25	Class B
NCS-55A1-24H	G.8265.1	Release 6.5.2	
	G.8275.1	Release 6.5.2	
	G.8275.2	Release 6.5.2	
	G.8273.2	Release 6.5.2	Class B

Hardware Variant	Features	Cisco IOS XR Release	Comments
NCS55A2-MOD	G.8265.1	Release 6.5.1	
	G.8275.1	Release 6.5.1	
	G.8275.2	Release 6.5.1	
	G.8273.2	Release 6.5.1	Class B
RP:NC55-RP-E Linecard:NC55-MOD-A-S	BITS	Release 6.5.1	SyncE is not supported on 25GE or 100GE interfaces, when they are used in 1G mode.
	G.8265.1	Release 6.5.1	
	G.8275.1	Release 6.5.1	
	G.8275.2	Release 6.5.1	This profile is supported from Release 6.5.1 for Ipv4.
	G.8273.2	Release 6.5.1	Class B
RP:NC55-RP-E Linecard:NC55-36X100G-A-SE	G.8273.2	Release 6.3.2	Class B
	BITS	Release 6.3.2	SyncE is not supported on 25GE or 100GE interfaces, when they are used in 1G mode.
	G.8265.1	Release 6.3.2	
	G.8275.1	Release 6.3.2	
	G.8275.2	NA	
	G.8273.2	Release 6.3.2	Class B
NCS5501-SE	G.8265.1	Release 6.3.2	
	G.8275.1	Release 6.3.2	Class B
	G.8275.2	Release 6.3.2	
	GNSS External	Release 6.3.2	

Hardware Variant-Specific Behaviour

The line card NC55-32T16Q4H-AT displays the following behaviour when configured for PTP:

- The timing features are supported on all ports of the line cards.
- The NC55-RP2-E does not support PTP on the 1588 Port.

- To configure Class C for the profile G.8273.2 when you use NC55-RP2-E with line card NC55-32T16Q4H-AT, follow the example below:

```
RP/0/RP0/CPU0:router# config
RP/0/RP0/CPU0:router(config)#frequency synchronization
RP/0/RP0/CPU0:router(config-freqsync)#timing-accuracy enhanced
RP/0/RP0/CPU0:router(config-freqsync)#commit
```

While configuring PTP on the NCS-57C3-MODS-SYS and NCS-57C3-MOD-SYS, the location must be:

0/0/CPU0:router instead of RP/0/RP0/CPU0:router



Note Cisco NCS 5500 Series Routers support 64 PTP clients at 64 PPS sync packet rate.

Timing features are supported on the following MPAs:

- NC57-MPA-12L-S
- NC55-MPA-2TH-S
- NC55-MPA-1TH2H-S
- NC55-MPA-1TH2H-HD-S
- NC55-MPA-4H-S
- NC55-MPA-4H-HD-S
- NC55-MPA-12T-S

Table 11: Timing Features Supported on MPAs

Hardware Variant	Features	Cisco IOS XR Release	Comments
NC57-MPA-1FH1D-S	PTP is supported on the following profiles: <ul style="list-style-type: none"> • G8265.1 • G8275.1 • G8275.2 • Default Profile 	Release 7.8.1	Class-C is supported only on QSFP 100G and 40G ports in native mode. Router processor: NC57-MOD-RP2-E with NCS-57C3-MOD-S and NCS-57C3-MOD-SE-S This feature provides only functionality support for PTP on QSFP 400G/200G and CFP2 DCO ports.

Hardware Variant	Features	Cisco IOS XR Release	Comments
NC55-MPA-4H-S	<p>PTP is supported on the following profiles:</p> <ul style="list-style-type: none"> • G8265.1 • G8275.1 • G8275.2 • Default Profile 	Release 7.7.1	Class B
NC55-MPA-2TH-S	<p>PTP is supported on the following profiles:</p> <ul style="list-style-type: none"> • G8265.1 • G8275.1 • G8275.2 • Default Profile 	Release 7.7.1	<p>PTP is supported on 100G and 200G mode.</p> <p>Route Processor:RP2-E</p>
NC55-MPA-1TH2H-S	<p>PTP is supported on the following profiles:</p> <ul style="list-style-type: none"> • G8265.1 • G8275.1 • G8275.2 • Default Profile 	Release 7.7.1	<p>PTP is supported on 100G mode.</p> <p>Route Processor:RP2-E</p> <p>Class C is not supported on 200G port.</p>
NC57-MPA-12L-S	<p>IEEE1588 timestamping on the PHY</p> <p>MPA is supported on the following line cards:</p> <ul style="list-style-type: none"> • NCS-55A2-MOD-HD-S: Class B. • NCS-57C3-MODS-SYS: Class C • NC57-MOD-S, Line Card (Class B on RPE and Class C on RP2E with enhanced accuracy CLI) • NC55-MOD-A-S (Class B on both RPE and RP2E) 	Release 7.6.1	<p>Route Processors:</p> <ul style="list-style-type: none"> • RP-E: Class B • RP2-E Enhanced: Class C

Breakout Timing Support

PTP Profiles 8275.1 and 8275.2 are supported on breakout ports on the following hardware PIDs:

Table 12: Breakout Timing Support Hardware Matrix

Hardware PID	Client Port	Server Port
NCS-55A1-36H-S	100G	25G Breakout
NCS-55A1-36H-S	100G	10G Breakout
NCS-55A1-48Q6H	10G	25G Breakout
NCS-55A1-48Q6H	100G	25G Breakout
NCS55A1-24Q6H-S	1G	25G Breakout
NCS55A1-24Q6H-S	10G	25G Breakout
NCS55A1-24Q6H-S	100G	25G Breakout
NCS-5501-SE	1G	10G Breakout
NCS-5501-SE	1G	25G Breakout
NCS-5501-SE	10G	10G Breakout
NCS-5501-SE	10G	25G Breakout
NC57-36H6D-S	25G	25G Breakout
NC57-36H6D-S	25G	10G Breakout
NC57-36H6D-S	10G	25G Breakout
NC57-36H6D-S	10G	10G Breakout
NC57-36H-SE	10G	10G Breakout



Note The server ports 100G and 40G are used as breakout for 4x25G and 4x10G respectively. The client ports are used as direct ports of different port speeds as presented in the table, *Breakout Timing Support Hardware Matrix*.

Slow Tracking

Under normal configured conditions, any change in offset triggers an immediate reaction in the servo. With the Slow Tracking feature enabled, the servo corrects the phase offset based on the configured value. If the phase offset exceeds the acceptable range, servo goes into Holdover state. In such a condition, the Slow Tracking feature becomes inactive and the servo corrects itself to the latest offset and goes into Phase locked state. Slow Tracking becomes active again.



- Note**
- The supported slow tracking rate range is from 8-894 nanoseconds per second and must be in multiples of 8.
 - This feature is active only when servo is in Phase locked mode.

```
Router:# config
ptp
clock
domain 24
profile g.8275.1 clock-type T-BC
!
profile profile1
multicast target-address ethernet 01-1B-19-00-00-00
transport ethernet
sync frequency 16
clock operation one-step
announce frequency 8
delay-request frequency 16
!
physical-layer-frequency
servo-slow-tracking 16
!
```

Double Failure Clock Class Over-ride

Table 13: Feature History Table

Feature Name	Release Information	Feature Description
PTP Double Failure Clock Class	Release 7.7.1	This feature enables you to configure a clock class that will over-ride the existing class during a state of double-failure where PTP and SyncE are lost. This feature introduces the double-failure-clock-class command.

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. The default domain number is 4.
- **Port Numbers:** All PTP port numbers can only be one (1) because all clocks in this profile network are Ordinary Clocks.

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.

G.8275.1

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:

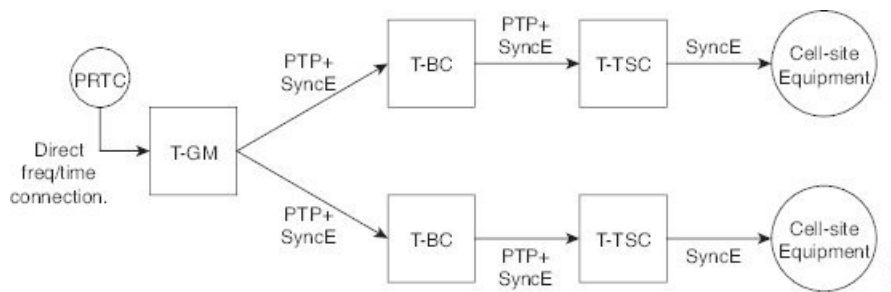
- Synchronization Model: G.8275.1 profile adopts hop-by-hop synchronization model. Each network device in the path from master to slave synchronizes its local clock to upstream devices and provides synchronization to downstream devices.
- Clock Selection: G.8275.1 profile also defines an alternate BMCA 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 4: A Sample G.8275.1 Topology



Route Processor Fail Over

The Route processor fail over (RPFO) or stateful switchover (SSO) feature is supported on the Profile G.8275.1 on the Telecom Boundary Clock. Over a switchover, the time error might jump to a high value after losing lock with the T-GM clock. With this feature enabled, the time error will not increase by more than 400 nanoseconds over a switchover.



Note You must wait for a specific time duration to lapse to build holdover.

G.8275.2

Table 14: Feature History Table

Feature Name	Release Information	Description
ITU-T G.8275.2 and Default PTP profiles over IPv6	Release 7.8.1	For ITU-T G.8275.2 and the IEEE 1588 default PTP profiles, the encapsulation type for PTP packet transport is now extended to IPv6. This feature modifies the transport command to include the keyword ipv6 .

The G.8275.2 is a PTP profile for use in telecom networks where phase or time-of-day synchronization is required. It differs from G.8275.1 in that it is not required that each device in the network participates in the PTP protocol. Also, G.8275.2 uses PTP over IPv4 in unicast mode.

Effective Cisco IOS XR Software Release 7.8.1, the G.8275.2 is capable of using PTP over IPv6 as well. You can now use the **transport ipv6** command to set this encapsulation type.

The G.8275.2 profile is based on the partial timing support from the network. Hence nodes using G.8275.2 are not required to be directly connected.

The G.8275.2 profile is used in mobile cellular systems that require accurate synchronization of time and phase. For example, the fifth generation (5G) of mobile telecommunications technology.



Note G.8275.2 profile is supported on Cisco NCS 5500 Series Routers. However, the performance standards of this profile is not aligned with any of the ITU-T standards because performance specifications for G.8275.2 profile has not yet been made available by ITU-T.

For more information on hardware that supports G.8275.2 profile configurations, refer to [PTP Support Information](#) section in this chapter.

Features of G.8275.2 profile are:

- *Clock Selection*: G.8275.2 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



Note See ITU-T G.8275.2 document to determine the valid values for Clock Class parameter.

- *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 unicast transport mode.
- *Packet Rates*:
 - Synchronization/Follow-Up—minimum is one packet-per-second and maximum of 128 packets-per-second.

- Packet rate for Announce packets—minimum of one packet-per-second and maximum of eight packets-per-second.
- Delay-Request/Delay-Response packets—minimum is one packet-per-second and maximum of 128 packets-per-second
- *Transport Mechanism*: G.8275.2 profile supports only IPv4 PTP transport mechanism.
- *Mode*: G.8275.2 profile supports transport of data packets only in unicast mode.
- *Clock Type*: G.8275.2 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.8275.2 profile network ranges from 44 to 63. The default domain number is 44.

Starting from Release 7.2.1, PTP Multi-profile is supported for the below combination of PTP profiles:

- G8275.1
- G8275.2

PTP Virtual Port

Table 15: Feature History Table

Feature Name	Release Information	Feature Description
Use PTP Virtual Port to Select Timing Source	Release 7.7.1	<p>You can now select the best available timing source for your routers by using the PTP Virtual Port (VP) feature.</p> <p>This feature allows you to compare, select, and advertise the best clock source between a PTP server and other local timing sources connected to the routers.</p> <p>PTP Virtual Port is now available on the following routers:</p> <ul style="list-style-type: none"> • NCS-57C3-MODS-SYS • NCS-57B1-6D24-SYS <p>VP is an external frequency, phase, and time input interface on a Telecom Boundary Clock (T-BC), and thus participates in the timing source selection.</p> <p>Some useful information:</p> <ul style="list-style-type: none"> • ITU-T Telecom Profiles for PTP

With an increase in diversification in deployment of backhaul networks, there is a need to have the ability to select and advertise the best clock source between a PTP server and other local timing sources connected to the device. ITU-T G.8275 specifies associating a virtual PTP port to an external clock input of the device. This allows the external clock inputs to participate in PTP protocol to select the best clock source between a PTP server and other local timing sources connected to the device.

G.8275.1 introduces the concept of a virtual port on the T-BC. A virtual port is an external frequency, phase, and time input interface on a T-BC, which can participate in the source selection.

Configuration Guidelines and Restrictions

- Virtual port is supported for G8275.1 and G8275.2 in hybrid and non-hybrid modes.
- Virtual port configuration is not allowed under Ordinary Clocks.

Configure Virtual Port

You can configure virtual port on the G8275.1 and G8275.2 profiles in hybrid and non-hybrid modes.

For virtual port configuration to work, GNSS or Sync2 must be configured.

```
Router:# config
virtual-port
offset-scaled-log-variance 20061
priority2 128
clock-class 6
clock-accuracy 33
local-priority 128
!
time-of-day priority 90
```

Verification

To verify the virtual port details, use **show ptp platform servo** command in global PTP configuration mode.

```
RP/0/RP0/CPU0:ios#sh ptp platform
servo
Sun Jan  9 14:51:47.283
UTC
Servo status:
Running
Servo stat_index:
2
Device status:
PHASE_LOCKED
Servo Mode:
Electrical
Servo log level:
0
Phase Alignment Accuracy: 11
ns
Sync timestamp updated:
10092
Sync timestamp discarded:
0
Delay timestamp updated:
10091
Delay timestamp discarded:
0
Previous Received Timestamp T1: 1642091334.238048486 T2: 1642091334.238048504 T3:
1642091334.217949799 T4: 1642091334.217949839
Last Received Timestamp T1: 1642091334.238048486 T2: 1642091334.238048504 T3:
1642091334.281936816 T4: 1642091334.281936855
Offset from master: 0 secs, 0
nsecs
Mean path delay : 0 secs, 0
nsecs
setTime():0 stepTime():0
adjustFreq():0
Last setTime: 0.000000000 flag:0 Last stepTime:0 Last adjustFreq:0
```

Assisted Partial Timing Support

Table 16: Feature History Table

Feature Name	Release Information	Feature Description
Use APTS to Select Timing Source	Release 7.7.1	<p>Assisted Partial Timing Support (APTS) enables you to select timing and synchronization for mobile backhaul networks.</p> <p>APTS is now available on the following routers:</p> <ul style="list-style-type: none"> • NCS-57C3-MODS-SYS • NCS-57B1-6D24-SYS <p>APTS allows for proper distribution of phase and time synchronization in the network.</p> <p>Some useful information:</p> <ul style="list-style-type: none"> • ITU-T Telecom Profiles for PTP

The Assisted Partial Timing Support (APTS) enables you to deliver accurate timing and synchronization in mobile backhaul networks. ITU-T G.8275 specifies the APTS architectures where PTP is used as a backup timing source to a local time reference. The local time reference is generally a GNSS-based PRTC clock.

Configuration Guidelines and Restrictions

- Assisted Partial Timing Support (APTS) is supported only for G8275.2 non-hybrid profiles.

Configure APTS

You can configure APTS on the G8275.2 profile in non-hybrid mode.

```

Router:#
ptp
apts
clock
domain 44
profile g.8275.2 clock-type T-BC
!
profile profile1
transport ipv4
sync frequency 64
clock operation one-step
announce frequency 8
delay-request frequency 64
!
virtual-port
offset-scaled-log-variance 20061
priority2 128
clock-class 6

```



```

clock-accuracy 33
local-priority 127
!
frequency priority 254
time-of-day priority 90
log

```

Verification

To verify the apts details, use **show ptp local-clock** command.

```

RP/0/RP0/CPU0:ios#sh ptp local-clock
Sun Jan  9 14:52:15.211 UTC
Clock ID: 94aef0fffe0b8700
Clock properties:
  Domain: 44, Priority1: 128, Priority2: 128, Class: 165
  Accuracy: 0xfe, Offset scaled log variance: 0xffff
  Time Source: GPS
  Timescale: PTP
  Frequency-traceable, Time-traceable
  Current UTC offset: 37 seconds (valid)
Virtual Port:
  Configured: True, Connected: True
  Clock-class: 6
  Priority1: 128, Priority2: 128, Local Priority: 125
  Accuracy: 0x21, Offset scaled log variance: 0x4e5d
Local clock is grandmaster
APTS: Enabled

```

PTP Holdover Traceability Suppression

Table 17: Feature History Table

Feature Name	Release Information	Feature Description
PTP Holdover Traceability Suppression	Release 7.4.1	When a device which is configured as a Boundary clock (T-BC) loses synchronization with a quality Primary clock, to ensure that the downstream nodes continue to receive the configured clock class for a specified duration, and it's traceable you can configure this feature.

When the device loses synchronization with a quality Primary clock, to ensure that the downstream nodes continue to receive the configured clock class, and it's traceable you can configure this feature.

This feature enables the device which is configured as a boundary clock (T-BC) with PTP Profiles G.8275.1 or G.8275.2 to send out the configured clock-class as holdover clock-class and the time traceability flag to be set as TRUE for the specified duration. This is to ensure the down-stream nodes do not have an impact as this is a deviation from prescribed G.8275.1 ITU-T standards.



- Note**
- There are PTP flaps during switchovers or ISSU as the PTP holdover timer is running on the active RSP.
 - Once the configured holdover override duration has lapsed and the device is unable to receive a quality Primary clock within this duration, the device sends the prescribed default clock class of 165, and the traceability flag will be set as FALSE to advertise loss of clock to downstream nodes.

Configuring PTP Holdover traceability suppression

This section describes how to configure the PTP holdover traceability suppression feature:

```
Router# config
Router(config)# ptp
Router(config-ptp)# holdover-spec-duration 1000
Router(config-ptp)# holdover-spec-clock-class 135
Router(config-ptp)# uncalibrated-traceable-override
Router(config-ptp)# holdover-spec-traceable-override
```

Configuring PTP

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 tasks you need to configure PTP on Cisco IOS XR software.



- Note** When a subinterface is configured with encapsulation default or untag configuration, you must configure PTP on that subinterface, instead of the main interface.

Configuring Global G.8275.1 Profile

This below 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.8275.1 profile as an example:



- Note** Prior to Cisco IOS XR Software Release 6.3.3, the default PTP timers for G2875.1 were not set to standard values. This could lead to interoperability issues with other routers running the timers with updated values. Hence, to prevent such issues arising due to difference in packet rates, you must explicitly configure the **announce interval** value to 8, **sync frequency** value to 16 and **delay-request frequency** value to 16 while configuring global g.2875.1 profile.

```
RP/0/RP0/CPU0:router# config terminal
RP/0/RP0/CPU0:router(config)# ptp
RP/0/RP0/CPU0:router(config-ptp)# clock
RP/0/RP0/CPU0:router(config-ptp-clock)# domain 24
RP/0/RP0/CPU0:router(config-ptp-clock)# profile g.8275.1 clock-type T-BC
RP/0/RP0/CPU0:router(config-ptp-clock)# exit
RP/0/RP0/CPU0:router(config-ptp)# profile slave
```

```

RP/0/RP0/CPU0:router(config-ptp-profile)# multicast target-address ethernet 01-1B-19-00-00-00
RP/0/RP0/CPU0:router(config-ptp-profile)# transport ethernet
RP/0/RP0/CPU0:router(config-ptp-profile)# sync frequency 16
RP/0/RP0/CPU0:router(config-ptp-profile)# announce frequency 8
RP/0/RP0/CPU0:router(config-ptp-profile)# delay-request frequency 16
RP/0/RP0/CPU0:router(config-ptp-profile)# exit
RP/0/RP0/CPU0:router(config-ptp)# profile master
RP/0/RP0/CPU0:router(config-ptp-profile)# multicast target-address ethernet 01-1B-19-00-00-00
RP/0/RP0/CPU0:router(config-ptp-profile)# transport ethernet
RP/0/RP0/CPU0:router(config-ptp-profile)# sync frequency 16
RP/0/RP0/CPU0:router(config-ptp-profile)# announce frequency 8
RP/0/RP0/CPU0:router(config-ptp-profile)# delay-request frequency 16
RP/0/RP0/CPU0:router(config-ptp-profile)# exit
RP/0/RP0/CPU0:router(config-ptp)# physical-layer-frequency
RP/0/RP0/CPU0:router(config-ptp)# log
RP/0/RP0/CPU0:router(config-ptp-log)# servo events
RP/0/RP0/CPU0:router(config-ptp-log)# commit

```

Verification

To display the configured PTP profile details, use **show run ptp** command.

```

RP/0/RP0/CPU0: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.

```

RP/0/RP0/CPU0:router# configure terminal
RP/0/RP0/CPU0:router(config)# interface HundredGigE0/0/0/0
RP/0/RP0/CPU0:router(config-if)# ptp
RP/0/RP0/CPU0:router(config-if-ptp)# profile master
RP/0/RP0/CPU0:router(config-if-ptp)# port state master-only
RP/0/RP0/CPU0:router(config-if-ptp)# commit

```

Verification

To verify the port state details, use **show run interface** *interface-name* command.

```
RP/0/RP0/CPU0: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.

```
RP/0/RP0/CPU0:router# configure terminal
RP/0/RP0/CPU0:router(config)# interface HundredGigE0/0/0/1
RP/0/RP0/CPU0:router(config-if)# ptp
RP/0/RP0/CPU0:router(config-if-ptp)# profile slave
RP/0/RP0/CPU0:router(config-if-ptp)# port state slave-only
RP/0/RP0/CPU0:router(config-if-ptp)# commit
```

Verification

To verify the port state details, use **show run interface** *interface-name* command.

```
RP/0/RP0/CPU0: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. By default, the hybrid mode is used, regardless of the physical-layer-frequency configuration.
- G.8275.2 PTP profile supports both hybrid mode and non-hybrid mode. By default, the non-hybrid mode is used. Hybrid mode is used only when the physical-layer-frequency is configured.

To configure PTP Hybrid mode:

1. Configure Global Frequency Synchronization

```
RP/0/RP0/CPU0:router(config)# frequency synchronization
RP/0/RP0/CPU0: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.

```
RP/0/RP0/CPU0:router(config)# interface GigabitEthernet 0/0/0/0
RP/0/RP0/CPU0:router(config-if)# frequency synchronization
RP/0/RP0/CPU0:router(config-if-freqsync)# selection input
RP/0/RP0/CPU0:router(config-if-freqsync)# time-of-day-priority 100
RP/0/RP0/CPU0:router(config-if-freqsync)# commit
```

3. Configure Global PTP. To configure PTP as source for ToD, use ToD priority values in the range from 1 (highest priority) to 254 (lowest priority). Use frequency from the physical layer.

```
RP/0/RP0/CPU0:router(config)# ptp
RP/0/RP0/CPU0:router(config-ptp)# physical-layer-frequency
RP/0/RP0/CPU0:router(config-ptp)# time-of-day priority 1
RP/0/RP0/CPU0:router(config)# commit
```

4. Configure PTP Interface. To enable this interface as a PTP Master, use **master** command in ptp-interface configuration mode.

```
RP/0/RP0/CPU0:router(config)# interface GigabitEthernet 0/0/0/2
RP/0/RP0/CPU0:router(config-if)# ipv4 address 10.0.0.1/24
RP/0/RP0/CPU0:router(config-if)# ptp
RP/0/RP0/CPU0:router(config-if-ptp)# master ipv4 10.0.0.2
RP/0/RP0/CPU0:router(config-if-ptp)# commit
```

Verifying PTP Hybrid Mode

```
RP/0/RP0/CPU0:router # show frequency synchronization selection
```

```
Tue Feb  6 06:34:17.627 UTC
Node 0/0/CPU0:
=====
Selection point: ETH_RXMUX (1 inputs, 1 selected)
  Last programmed 3d23h ago, and selection made 3d23h ago
  Next selection points
    SPA scoped      : None
    Node scoped     : None
    Chassis scoped: T0-SEL-B 1588-SEL
    Router scoped  : None
  Uses frequency selection
  S  Input                                     Last Selection Point      QL  Pri  Status
  == =====
  1  GigabitEthernet0/0/0/2                   n/a   PRC      1  Available
Selection point: LC_TX_SELECT (1 inputs, 1 selected)
  Last programmed 3d23h ago, and selection made 3d23h ago
  Next selection points
    SPA scoped      : None
    Node scoped     : None
    Chassis scoped: None
    Router scoped  : None
  Uses frequency selection
  Used for local line interface output
  S  Input                                     Last Selection Point      QL  Pri  Status
  == =====
  7  GigabitEthernet0/0/0/2                   0/RP0/CPU0 T0-SEL-B 1    PRC  1  Available
Node 0/RP0/CPU0:
=====
Selection point: T0-SEL-B (3 inputs, 1 selected)
  Last programmed 1d00h ago, and selection made 00:36:33 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  GigabitEthernet0/0/0/2 0/0/CPU0 ETH_RXMUX 1          PRC  1  Locked
        PTP [0/RP0/CPU0] n/a          SEC  254  Available
        Internal0 [0/RP0/CPU0] n/a      SEC  255  Available

    Selection point: 1588-SEL (2 inputs, 1 selected)
    Last programmed 3d23h ago, and selection made 00:36:33 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  GigabitEthernet0/0/0/2 0/0/CPU0 ETH_RXMUX 1          PRC  1  Locked
        Internal0 [0/RP0/CPU0] n/a      SEC  255  Available

    Selection point: CHASSIS-TOD-SEL (2 inputs, 1 selected)
    Last programmed 1d00h ago, and selection made 1d00h ago
    Next selection points
        SPA scoped      : None
        Node scoped     : None
        Chassis scoped: None
        Router scoped   : None
    PRC  1  Locked
    SEC  255  Available
    Last Selection Point
    QL  Pri  Status
    Uses time-of-day selection
    S  Input                Last Selection Point          Pri  Time  Status
    == =====
    1  PTP [0/RP0/CPU0]      n/a                          100  Yes   Available
        GigabitEthernet0/0/0/2 0/RP0/CPU0 TO-SEL-B 1    100  No    Available

```

Configuring PTP Telecom Profile Interface

This procedure describes the steps involved to create an interface for PTP ITU-T Telecom Profiles.



Note

- PTP Telecom Profile Interface is not supported on NCS-57C3-MODS-SYS and NCS-57C3-MOD-SYS line cards
- It is also possible to make these definitions within a global PTP profile and attach them to the interface using the profile command in PTP interface configuration mode.

1. To configure an interface, use **interface type interface-path-id** command in the configuration mode.

```
RP/0/RP0/CPU0:router(config)# interface gigabitethernet 0/1/0/1
```

2. To enter the PTP configuration mode for the given interface, use **ptp** command in the interface configuration mode.

```
RP/0/RP0/CPU0:router(config-if)# ptp
```

- To configure a PTP profile (or specify a previously defined profile), use **profile name** command in the ptp-interface configuration mode.



Note Any additional commands entered in ptp-interface configuration mode overrides the global profile settings.

```
RP/0/RP0/CPU0:router(config-if-ptp)# profile slave
```

- To configure frequency for Sync or Delay-request messages for the given ptp interface, use **sync frequency rate** command or **delay-request frequency rate** command appropriately in the ptp-interface configuration mode. The valid configurable values are **2, 4, 8, 16, 32, 64 or 128**.

```
RP/0/RP0/CPU0:router(config-if-ptp)# sync frequency 128
```

```
RP/0/RP0/CPU0:router(config-if-ptp)# delay-request frequency 128
```

- To configure duration for different PTP messages, use one of the following commands in the ptp-interface configuration mode: **announce grant-duration duration**, **sync grant-duration duration**, or **delay-response grant-duration duration**. The duration value can be between **60 and 1000 seconds**.



Note This duration value represents the length of grant that is requested by a port in Slave state and represents the maximum grant-duration allowed when the port is in Master state.

```
RP/0/RP0/CPU0:router(config-if-ptp)# announce grant-duration 120
```

```
RP/0/RP0/CPU0:router(config-if-ptp)# sync grant-duration 120
```

```
RP/0/RP0/CPU0:router(config-if-ptp)# delay-response grant-duration 120
```

- To configure a timeout value, length of time by when a PTP message must be received (before PTSF-lossSync is raised), use one of the following commands in the ptp-interface configuration mode: **sync timeout timeout** or **delay-response timeout timeout**. The timeout value can be between **100 to 10000 micro seconds**.

```
RP/0/RP0/CPU0:router(config-if-ptp)# sync timeout 120
```

```
RP/0/RP0/CPU0:router(config-if-ptp)# delay-response timeout 120
```

- To configure a response for unicast-grant invalid-request, use **unicast-grant invalid-request {reduce | deny}** command. The response for requests with unacceptable parameters would either be denied or granted with reduced parameters.

```
RP/0/RP0/CPU0:router(config-if-ptp)# unicast-grant
invalid-request reduce
```

- To configure IPv4 address for a PTP master, use **master ipv4 ip-address** command in the ptp-interface configuration mode.

```
RP/0/RP0/CPU0:router(config-if-ptp)# master ipv4 1.7.1.2
```

- To override the clock-class received in Announce messages from the specified Master, use **clock-class class** command in the ptp-master-interface configuration mode. The class values can range from **0 to 255**.

```
RP/0/RP0/CPU0:router(config-if-ptp-master)# clock-class 2
```

Verification

To display the PTP interface details, use **show ptp interfaces brief** command.

```
RP/0/RP0/CPU0:router# show ptp interfaces brief
Fri Feb  9 11:16:45.248 UTC
Intf          Port      Port      Encap      Line      Mechanism
Name          Number    State
-----
Gi0/1/0/0     1         Slave     IPv4       up        1-step DRRM
Gi0/0/0/40    2         Master    IPv4       up        1-step DRRM
```

To verify the configured profile details, use **show run interface interface-name** command.

```
RP/0/RP0/CPU0:router# show run interface Gi0/0/0/33
Wed Feb 28 11:49:16.940 UTC
interface GigabitEthernet0/0/0/33
 ptp
  profile slave
  transport ipv4
  sync frequency 64
  clock operation one-step
  delay-request frequency 64
  !
  physical-layer-frequency
  !
  ipv4 address 21.1.1.2 255.255.255.0
  frequency synchronization
  selection input
  priority 5
  wait-to-restore 0
  !
```

Configuring PTP Telecom Profile Clock

This procedure describes the steps involved to configure PTP clock and its settings to be consistent with ITU-T Telecom Profiles for Frequency.

- To enter the PTP configuration mode, use **ptp** command in the configuration mode.

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

- To enter the PTP-clock configuration mode, use **clock** command in the ptp-configuration mode.

```
RP/0/RP0/CPU0:router(config-ptp)# clock
```


- To configure the domain-number for a PTP profile, use **domain number** command in the ptp-configuration mode. The allowed domain number range for G.8265.1 profile is between **4 and 23** and the range for G.8275.1 profile is between **24 and 43**.

```
RP/0/RP0/CPU0:router(config-ptp)# domain 24
```

- To exit the ptp-clock configuration mode, use **exit** command.

```
RP/0/RP0/CPU0:router(config-ptp-clock)# exit
```

- To configure the desired telecom profile and the clock type for the profile, use **clock profile {g.8275.1 | g.8275.2} clock-type {T-GM | T-BC | T-TSC}** command in the ptp configuration mode. For **g.8265.1** clock profile, clock type is either master or slave.



Note The **clock-selection telecom-profile** and **clock-advertisement telecom-profile** commands are deprecated from Release 6.1.2. They are replaced by the **clock profile** command.

```
RP/0/RP0/CPU0:router(config-ptp)# clock profile g.8275.1 clock-type T-GM
```

Verification

To display the configured PTP clock profile details, use **show run ptp** command.

```
RP/0/RP0/CPU0:router# show run ptp
ptp
clock
  domain 24
  profile g.8275.1 clock-type T-GM
  timescale PTP
  time-source GPS
  clock-class 6
!
profile master
  transport ethernet
  sync frequency 16
  announce interval 1
  delay-request frequency 16
!
profile master1
  transport ethernet
  sync frequency 64
  announce interval 1
  delay-request frequency 64
!
```

To verify that PTP has been enabled on the router and the device is in LOCKED Phase, use **show ptp platform servo** command.

```
RP/0/RP0/CPU0:router # show ptp platform servo

Fri Feb  9 11:16:54.568 UTC
Servo status: Running
Servo stat_index: 2
Device status: PHASE_LOCKED
```

```

Servo log level: 0
Phase Alignment Accuracy: 1 ns
Sync timestamp updated: 111157
Sync timestamp discarded: 0
Delay timestamp updated: 111157
Delay timestamp discarded: 0
Previous Received Timestamp T1: 1518155252.263409770 T2: 1518155252.263410517 T3:
1518155252.287008362 T4: 1518155252.287009110
Last Received Timestamp T1: 1518155252.325429435 T2: 1518155252.325430194 T3:
1518155252.348938058 T4: 1518155252.348938796
Offset from master: 0 secs, 11 nsecs
Mean path delay : 0 secs, 748 nsecs
setTime():2 stepTime():1 adjustFreq():10413 adjustFreqTime():0
Last setTime: 1.000000000 flag:1 Last stepTime:-736216, Last adjustFreq:465

```

Configuring PTP Delay Asymmetry

Table 18: Feature History Table

Feature Name	Release Information	Description
PTP Delay Asymmetry	Release 7.3.1	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.
PTP Delay Asymmetry	Release 7.6.1	You can configure static asymmetry such that any delays on Precision Time Protocol (PTP) paths are accounted for, and the PTP synchronization remains accurate, thus avoiding any impact to clock settings for all devices in a network.

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**

- PTP delay asymmetry is not supported on NCS-57C3-MODS-SYS and NCS-57C3-MOD-SYS line cards
- 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: 80e01dffffe8ab73f
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: 80e01dffffe8ab73f
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
```

Configuration Examples

Slave Configuration Example

The following example shows a PTP slave configuration:

```
interface TenGigE 0/1/0/5
 ptp
  profile slave
  transport ipv4
  port state slave-only
  master ipv4 1.7.1.2
  !
  announce interval 1
  !
  ipv4 address 1.7.1.1 255.255.255.0
 !
```

Master Configuration Example

This example shows a PTP master configuration:

```
ptp
 profile master
 transport ipv4
 announce interval 1
 !
 ipv4 address 1.7.1.2 255.255.255.0
 !
```

PTP Hybrid Mode Configuration Example

This example shows the configuration of PTP hybrid mode:

```
ptp
 time-of-day priority 10
 !
 interface GigabitEthernet0/1/1/0
  ptp
   transport ipv4
   port state slave-only
   master ipv4 1.7.1.2
   !
   sync frequency 64
   announce interval 1
   delay-request frequency 64
   !
 interface GigabitEthernet 0/1/0/1
  ipv4 address 1.7.1.2 255.255.255.0
  speed 100
```

```

frequency synchronization
selection input
priority 10
wait-to-restore 0
ssm disable
time-of-day-priority 100
!
```

ITU-T Telecom Profile Examples:

G.8265.1 Profile Configuration Examples

Master Global Configuration:

```

ptp
clock
domain 4
profile g.8265.1
!
profile master
transport ipv4
sync frequency 16
announce interval 1
delay-request frequency 16
interface gi 0/2/0/4
ptp
profile master
transport ipv4
clock operation two-step
!
ipv4 address 17.1.1.1/24
```

Slave Global Configuration:

```

ptp
clock
domain 4
profile g.8265.1
!
profile slave
transport ipv4
sync frequency 16
announce interval 1
delay-request frequency 16
interface gi 0/1/0/0
ptp
profile slave
transport ipv4
Master ipv4 18.1.1.1
port state slave-only
!
clock operation two-step
!
ipv4 address 18.1.1.2/24
```

Configuring With Clock Type as T-Boundary Clock (T-BC)

```

ptp
 clock
 domain 4
 profile g.8265.1
 !
 profile master
 transport ipv4
 sync frequency 16
 announce interval 1
 delay-request frequency 16
 exit
 profile slave
 transport ipv4
 sync frequency 16
 announce interval 1
 delay-request frequency 16
 exit
 interface gi 0/2/0/4
 ptp
 profile slave
 transport ipv4
 Master ipv4 17.1.1.1
 port state slave-only
 !
 clock operation two-step
 !
 ipv4 address 17.1.1.2/24
 interface gi 0/2/0/0
 ptp
 profile master
 transport ipv4
 clock operation two-step
 !
 ipv4 address 18.1.1.1/24

```

G.8275.1 Profile Configuration Examples

Master Global Configuration:

```

ptp
 clock
 domain 24
 profile g.8275.1
 !
 profile master
 transport ethernet
 sync frequency 16
 announce frequency 8
 delay-request frequency 16
 interface gi 0/2/0/4
 ptp
 profile master
 transport ethernet
 multicast target-address ethernet 01-1B-19-00-00-00
 !

```

Slave Global Configuration:

```

ptp

```

```

clock
domain 24
profile g.8275.1 clock-type T-TSC
!
profile slave
transport ethernet
sync frequency 16
announce frequency 8
delay-request frequency 16
interface gi 0/1/0/0
ptp
profile slave
transport ethernet
multicast target-address ethernet 01-1B-19-00-00-00
!

```

Configuring With Clock Type as T-Boundary Clock (T-BC)

```

ptp
clock
domain 24
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 gi 0/2/0/4
ptp
profile slave
transport ethernet
multicast target-address ethernet 01-1B-19-00-00-00
!
interface gi 0/2/0/0
ptp
profile master
transport ethernet
multicast target-address ethernet 01-1B-19-00-00-00

```

G.8275.2 Profile Configuration Examples

Master Global Configuration:

```

ptp
clock
domain 44
profile g.8275.2 clock-type T-GM
!
profile master
transport ipv4
sync frequency 64
announce frequency 8

```



```

    unicast-grant invalid-request deny
    delay-request frequency 64
    !
    !

interface GigabitEthernet0/2/0/11
 ptp
  profile master
  !
  ipv4 address 17.1.1.1/24

```

Slave Global Configuration:

```

ptp
 clock
  domain 44
  profile g.8275.2 clock-type T-TSC
  !
 profile slave
  transport ipv4
  port state slave-only
  sync frequency 64
  announce frequency 8
  unicast-grant invalid-request deny
  delay-request frequency 64
  !
 log
  servo events
  best-master-clock changes
  !
 !
interface GigabitEthernet0/2/0/12
 ptp
  profile slave
  master ipv4 18.1.1.1
  !
  !
  ipv4 address 18.1.1.2/24
  !

```

Effective Cisco IOS XR Software Release 7.8.1, the encapsulation type for PTP packet transport is now extended to IPv6; you can now use the **transport ipv6** to set this encapsulation type.

Configuring With Clock Type as T-Boundary Clock (T-BC)

```

ptp
 clock
  domain 44
  profile g.8275.2 clock-type T-BC
  !
 profile slave
  transport ipv4
  port state slave-only
  sync frequency 64
  announce frequency 8
  unicast-grant invalid-request deny
  delay-request frequency 64
  !
 profile master
  transport ipv4
  sync frequency 64
  announce frequency 8

```

```

    unicast-grant invalid-request deny
    delay-request frequency 64
    !
    log
    servo events
    best-master-clock changes
    !
    !

interface GigabitEthernet0/2/0/11
 ptp
  profile master
  !
  ipv4 address 18.1.1.1/24
  !

interface GigabitEthernet0/2/0/12
 ptp
  profile slave
  master ipv4 17.1.1.1
  !
  !
  ipv4 address 17.1.1.2/24
  !

```

Effective Cisco IOS XR Software Release 7.8.1, the encapsulation type for PTP packet transport is now extended to IPv6; you can now use the **transport ipv6** command to set this encapsulation type.

Configure E-SyncE on Primary and Secondary Interface

Primary Interface

The following example shows how you can configure global sync on primary interface:

```

Router#configure terminal
Router(config)#frequency synchronization
Router(config-freqsync)#quality itu-t option 1
Router(config-freqsync)#clock-identity mac-address aaaa.bbbb.cccc
Router(config-freqsync)#clock-interface timing-mode system
Router(config-freqsync)#commit

```

The following example shows how you can configure sync on primary interface:

```

Router#configure terminal
Router(config)# interface HundredGigE0/0/0/11
Router(config-if)# frequency synchronization
Router(config-if)# quality transmit exact itu-t option 1 ePRTC
Router(config-if)# commit

```

Secondary Interface

The following example shows how you can configure global sync on secondary interface:

```

Router#configure terminal
Router(config)#frequency synchronization
Router(config-freqsync)#quality itu-t option 1
Router(config-freqsync)#clock-interface timing-mode system
Router(config-freqsync)#commit

```

The following example shows how you can configure sync on secondary interface:

```

Router#configure terminal
Router(config)# interface HundredGigE0/0/0/10
Router(config-if)# frequency synchronization
Router(config-if-freqsync)# selection input
Router(config-if-freqsync)# priority 10
Router(config-if-freqsync)# wait-to-restore 0
Router(config-if-freqsync)# commit

```



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.

Verification

Use the **show frequency synchronization** command if e-synce is configured.

```

Routerr#show frequency synchronization interfaces br
Flags: > - Up                D - Down                S - Assigned for selection
       d - SSM Disabled      x - Peer timed out    i - Init state
       s - Output squelched

Fl  Interface                QLrcv QLuse Pri  QLsnd Output driven by
====
>S  HundredGigE0/0/0/13     ePRTC ePRTC 31 ePRTC HundredGigE0/0/0/18
>S  HundredGigE0/0/0/18     ePRTC ePRTC 30 DNU  HundredGigE0/0/0/18
RP/0/RP0/CPU0:Shadowtower#sh frequency synchronization selection
Node 0/RP0/CPU0:
=====
Selection point: T0-SEL-B (3 inputs, 1 selected)
  Last programmed 02:41:55 ago, and selection made 02:41:04 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
  Used for local clock interface output
  S  Input                Last Selection Point          QL  Pri  Status
  == =====
  33 HundredGigE0/0/0/18   0/RP0/CPU0 ETH_RXMUX 33   ePRTC 30  Locked
    HundredGigE0/0/0/13   0/RP0/CPU0 ETH_RXMUX 22   ePRTC 31  Available
    Internal0 [0/RP0/CPU0] n/a                          SEC  255  Available

Selection point: 1588-SEL (3 inputs, 1 selected)
  Last programmed 02:41:55 ago, and selection made 02:41:04 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  Internal0 [0/RP0/CPU0] n/a                          SEC  255  Freerun
    HundredGigE0/0/0/18   0/RP0/CPU0 ETH_RXMUX 33   ePRTC 30  Available
    HundredGigE0/0/0/13   0/RP0/CPU0 ETH_RXMUX 22   ePRTC 31  Available

Selection point: CHASSIS-TOD-SEL (1 inputs, 1 selected)
  Last programmed 02:41:44 ago, and selection made 02:41:44 ago
  Next selection points
    SPA scoped      : None

```

Configure E-SyncE on Primary and Secondary Interface

Node scoped : None
 Chassis scoped: None
 Router scoped : None

Uses time-of-day selection

S	Input	Last Selection Point	Pri	Time	Status
1	HundredGigE0/0/0/18	0/RP0/CPU0 T0-SEL-B 33	100	No	Available

Selection point: ETH_RXMUX (2 inputs, 2 selected)

Last programmed 02:41:55 ago, and selection made 02:41:55 ago

Next selection points

SPA scoped : None
 Node scoped : T0-SEL-B 1588-SEL
 Chassis scoped: None
 Router scoped : None

Uses frequency selection

S	Input	Last Selection Point	QL	Pri	Status
33	HundredGigE0/0/0/18	n/a	ePRTC	30	Available
22	HundredGigE0/0/0/13	n/a	ePRTC	31	Available



CHAPTER 13

Synchronous Ethernet ESMC and SSM

Table 19: Feature History Table

Feature name	Release Information	Feature Description
Enhanced SyncE and extended ESMC	Release 7.9.1	<p>ITU-T G.8262.1 recommendation defines the requirements for timing devices used in synchronizing network equipment. For example, bandwidth, frequency accuracy, holdover, and noise generation.</p> <p>With Enhanced SyncE (eSyncE) and Extended Ethernet Synchronization Message Channel (eESMC) support, the NCS 5500 and NCS 5700 Series Routers are capable of handling the following SyncE clocks on the network:</p> <ul style="list-style-type: none"> • Enhanced ethernet equipment clock (eEEC) • Enhanced primary reference clock (ePRC) • Enhanced primar reference timing clock (ePRTC)

Synchronous Ethernet is an extension of Ethernet designed to provide the reliability found in traditional SONET/SDH and T1/E1 networks to Ethernet packet networks by incorporating clock synchronization features. It supports the Synchronization Status Message (SSM) and Ethernet Synchronization Message Channel (ESMC) for synchronous Ethernet clock synchronization.

Synchronous Ethernet incorporates the Synchronization Status Message (SSM) used in Synchronous Optical Networking (SONET) and Synchronous Digital Hierarchy (SDH) networks. While SONET and SDH transmit the SSM in a fixed location within the frame, Ethernet Synchronization Message Channel (ESMC) transmits the SSM using a protocol: the IEEE 802.3 Organization-Specific Slow Protocol (OSSP) standard.

The ESMC carries a Quality Level (QL) value identifying the clock quality of a given synchronous Ethernet timing source. Clock quality values help a synchronous Ethernet node derive timing from the most reliable source and prevent timing loops.

When configured to use synchronous Ethernet, the router synchronizes to the best available clock source. If no better clock sources are available, the router remains synchronized to the current clock source.

The router supports QL-enabled mode.

- [Frequency Synchronization Timing Concepts, on page 192](#)
- [SyncE Hardware Support Matrix, on page 193](#)
- [Configuring Frequency Synchronization, on page 197](#)
- [Configure E-SyncE on Primary and Secondary Interface , on page 198](#)
- [Verifying the Frequency Synchronization Configuration, on page 200](#)
- [Verifying the ESMC Configuration, on page 202](#)
- [Verifying Controllers Timing LEDs, on page 203](#)

Frequency Synchronization Timing Concepts

The Cisco IOS XR frequency synchronization infrastructure is used to select between different frequency sources to set the router backplane frequency and time-of-day. There are two important concepts that must be understood with respect to the frequency synchronization implementation.

Sources

A source is a piece of hardware that inputs frequency signals into the system or transmits them out of the 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, GPS, BITS.
- 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 timing source has a Quality Level (QL) associated with it which gives the accuracy of the clock. This QL information is transmitted across the network via SSMs over the Ethernet Synchronization Messaging Channel (ESMC) or SSMs contained in the SONET/SDH frames so that devices know the best available source to synchronize to. In order to define a preferred network synchronization flow, and to help prevent timing loops, you can assign priority values to particular timing sources on each router. The combination of QL information and user-assigned priority levels allows each router to choose a timing source to use to clock its SyncE and SONET/SDH interfaces, as described in the ITU standard G.781.

Selection Points

A selection point is any point where a choice is made between several frequency signals, and possibly one or more of them are selected. Selection points form a graph representing the flow of timing signals between the different cards in a router running Cisco IOS XR software. For example, one or multiple selection points select between the different Synchronous Ethernet inputs available on a single line card, and the result of these

selection points is forwarded to a selection point on the RSP to select between the selected source from each card.

The input signals to the selection points can be:

- Received directly from a source.
- The output from another selection point on the same card.
- The output from a selection point on a different card.

The output of a selection point can be used in a number of ways:

- Used to drive the signals sent out of a set of sources.
- As input into another selection point on the card.
- As input into a selection point on another card.

Use the 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.

Restrictions

- SyncE is not supported on Gigabit Ethernet 0/0/0/24 to 0/0/0/31 ports.
- The Precision Time Protocol (PTP) session flaps during Route Processor Failover (RPFO).

SyncE Hardware Support Matrix



Note

The table also contains support details of upcoming releases. You can read this table in context of the current release and see relevant *Release Notes* for more information on supported features and hardware.

This table provides a detailed information on the timing features that are supported on the following hardware variants.

Hardware Variant	Features	Cisco IOS XR Release	Comments
NCS-57D2-18DD-SYS	SyncE	Release 7.8.1	With this release, SyncE is supported on 400G, 100G and 40G ports.

Hardware Variant	Features	Cisco IOS XR Release	Comments
NCS-57C3-MOD-SYS NCS-57C3-MODS-SYS	E-SyncE	Release 7.9.1	
NC57-24DD	SyncE	Release 7.5.1	
NC57-18DD-SE	SyncE	Release 7.5.1	
NCS-57C1-48Q6-SYS	SyncE	Release 7.5.1	
	E-SyncE	Release 7.9.1	
RP:NC57-MOD-RP2-E with NCS-57C3-MOD-SYS	SyncE	Release 7.4.1	1G Fiber clock recovery is supported from IOS XR Release 7.6.1 on SFP28 ports 0-7, 40-55, and not on MPA.
RP:NC57-MOD-RP2-E with NCS-57C3-MODS-SYS	SyncE	Release 7.4.1	1G Fiber clock recovery is supported from IOS XR Release 7.6.1 on SFP28 ports 0-7, 36-51, and not on MPA.
RP: NC55-RP2-E Line card: NC57-36H6D-S	SyncE	Release 7.3.2	<ul style="list-style-type: none"> • Release 7.3.2 - Supports Compatible Mode only • Release 7.7.1 - Supports both Native and Compatible mode. • SyncE is not supported on 100GE interfaces, when they are used in 1G mode.
NCS-57B1-5DSE-SYS NCS-57B1-6D24-SYS	SyncE	Release 7.3.1	
	E-syncE	Release 7.9.1	
RP:NC55-RP-E with Line cards: NC55-MOD-A-S and NC55-32T16Q4H-AT	SyncE	Release 7.1.1	SyncE is not supported on 25GE or 100GE interfaces, when they are used in 1G mode.
RP:NC55-RP2-E with Line cards: NC55-MOD-A-S and NC55-32T16Q4H-AT	SyncE	Release 7.1.1	SyncE is not supported on 25GE or 100GE interfaces, when they are used in 1G mode.

Hardware Variant	Features	Cisco IOS XR Release	Comments
RP:NC55-RP2-E with Line card:NC55-32T16Q4H-AT	SyncE	Release 7.1.1	SyncE is not supported on 25GE or 100GE interfaces, when they are used in 1G mode.
NCS-55A1-36H-SE-S	SyncE	Release 7.0.1	SyncE is not supported on 25GE or 100GE interfaces, when they are used in 1G mode.
NCS-55A1-36H-S	SyncE	Release 7.0.1	SyncE is not supported on 25GE or 100GE interfaces, when they are used in 1G mode.
NCS-55A1-24Q6H-S NCS-55A1-24Q6H-SS	SyncE	Release 6.6.25	SyncE is not supported on 25GE or 100GE interfaces, when they are used in 1G mode.
NCS-55A1-48Q6H	SyncE	Release 6.6.25	SyncE is not supported on 25GE or 100GE interfaces, when they are used in 1G mode.
NCS-55A1-24H	SyncE	Release 6.5.2	SyncE is not supported on 25GE or 100GE interfaces, when they are used in 1G mode.
NCS55A2-MOD	SyncE	Release 6.5.1	SyncE is not supported on 25GE or 100GE interfaces, when they are used in 1G mode.
	E-syncE	Release 7.9.1	E-SyncE is not supported on 25GE or 100GE interfaces, when they are used in 1G mode.
RP:NC55-RP-E Linecard:NC55-MOD-A-S	SyncE	Release 6.5.1	SyncE is not supported on 100GE interfaces, when they are used in 1G mode.
RP:NC55-RP-E Linecard:NC55-36X100G-A-SE	SyncE	Release 6.3.2	SyncE is not supported on 25GE or 100GE interfaces, when they are used in 1G mode.

Hardware Variant	Features	Cisco IOS XR Release	Comments
NCS5501-SE	SyncE	Release 6.3.2	<p>SyncE is not supported on 25GE or 100GE interfaces, when they are used in 1G mode.</p> <p>SyncE is supported on 10G from ports 8 to 15, but it is not supported on these ports in 1G mode.</p>

SyncE features are supported on the following MPAs:

- NC57-MPA-12L-S
- NC55-MPA-2TH-S
- NC55-MPA-1TH2H-S
- NC55-MPA-1TH2H-HD-S
- NC55-MPA-4H-S
- NC55-MPA-4H-HD-S
- NC55-MPA-12T-S

Table 20: Timing Features Supported on MPAs

Hardware Variant	Features	Cisco IOS XR Release	Comments
NC57-MPA-1FH1D-S	SyncE	Release 7.8.1	<p>Class-C is supported only on QSFP 100G and 40G ports in native mode.</p> <p>Router processor: NC57-MOD-RP2-E with NCS-57C3-MOD-S and NCS-57C3-MOD-SE-S</p> <p>This feature provides only functionality support for SyncE on QSFP 400G/200G and CFP2 DCO ports.</p>
NC55-MPA-4H-S	SyncE	Release 7.7.1	Class B
NC55-MPA-2TH-S	SyncE	Release 7.7.1	<p>SyncE is supported on 100G and 200G mode.</p> <p>Route Processor:RP2-E</p>

Hardware Variant	Features	Cisco IOS XR Release	Comments
NC55-MPA-1TH2H-S	SyncE	Release 7.7.1	SyncE is supported on 100G mode. Route Processor:RP2-E Class C is not supported on 200G port.
NC57-MPA-12L-S	SyncE SyncE clock recovery	Release 7.6.1	Route Processors: <ul style="list-style-type: none"> • RP-E: Class B • RP2-E Enhanced: Class C

Configuring Frequency Synchronization

Enabling Frequency Synchronization on the Router

This task describes the router-level configuration required to enable frequency synchronization.

```
RP/0/RP0/CPU0:Router# configure
RP/0/RP0/CPU0:Router(config)# frequency synchronization
RP/0/RP0/CPU0:Router(config-freqsync)# clock-interface timing-mode system
RP/0/RP0/CPU0:Router(config-freqsync)# quality itu-t option 1 generation 1
RP/0/RP0/CPU0:Router(config-freqsync)# log selection changes
RP/0/RP0/CPU0:Router(config-freqsync)# commit
```

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.

```
RP/0/RP0/CPU0:R1#config terminal
RP/0/RP0/CPU0:R1(config)#interface TenGigabitEthernet 0/0/0/0
RP/0/RP0/CPU0:R1(config-if)#frequency synchronization
RP/0/RP0/CPU0:R1(config-if-freqsync)#selection input
RP/0/RP0/CPU0:R1(config-if-freqsync)#wait-to-restore 10
RP/0/RP0/CPU0:R1(config-if-freqsync)#priority 5
RP/0/RP0/CPU0:R1(config-if-freqsync)#quality transmit exact itu-t option 1 PRC
RP/0/RP0/CPU0:R1(config-if-freqsync)#quality receive exact itu-t option 1 PRC
RP/0/RP0/CPU0:R1(config-if-freqsync)#commit
or
RP/0/RP0/CPU0:router(config-freqsync)# commit
```

Configuring Frequency Synchronization on a Clock Interface

To enable a clock interface to be used as frequency input or output, you must configure the port parameters and frequency synchronization, as described in this task.

```
RP/0/RP0/CPU0:R1#configure
RP/0/RP0/CPU0:R1 (config)# clock-interface sync 2 location 0/RP0/CPU0
RP/0/RP0/CPU0:R1 (config-clock-if)# port-parameters
RP/0/RP0/CPU0:R1 (config-clk-parms)# gps-input tod-format cisco pps-input ttl
RP/0/RP0/CPU0:R1 (config-clk-parms)# exit
RP/0/RP0/CPU0:R1 (config-clock-if)# frequency synchronization
RP/0/RP0/CPU0:R1 (config-clk-freqsync)# selection input
RP/0/RP0/CPU0:R1 (config-clk-freqsync)# wait-to-restore 1
RP/0/RP0/CPU0:R1 (config-clk-freqsync)# quality receive exact itu-t option 1 PRC
```

Configure E-SyncE on Primary and Secondary Interface

Primary Interface

The following example shows how you can configure global sync on primary interface:

```
Router#configure terminal
Router (config)#frequency synchronization
Router (config-freqsync)#quality itu-t option 1
Router (config-freqsync)#clock-identity mac-address aaaa.bbbb.cccc
Router (config-freqsync)#clock-interface timing-mode system
Router (config-freqsync)#commit
```

The following example shows how you can configure sync on primary interface:

```
Router#configure terminal
Router (config)# interface HundredGigE0/0/0/11
Router (config-if)# frequency synchronization
Router (config-if)# quality transmit exact itu-t option 1 ePRTC
Router (config-if)# commit
```

Secondary Interface

The following example shows how you can configure global sync on secondary interface:

```
Router#configure terminal
Router (config)#frequency synchronization
Router (config-freqsync)#quality itu-t option 1
Router (config-freqsync)#clock-interface timing-mode system
Router (config-freqsync)#commit
```

The following example shows how you can configure sync on secondary interface:

```
Router#configure terminal
Router (config)# interface HundredGigE0/0/0/10
Router (config-if)# frequency synchronization
Router (config-if-freqsync)# selection input
Router (config-if-freqsync)# priority 10
Router (config-if-freqsync)# wait-to-restore 0
Router (config-if-freqsync)# commit
```



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.

Verification

Use the **show frequency synchronization** command if e-synce is configured.

```

Routerr#show frequency synchronization interfaces br
Flags: > - Up                D - Down                S - Assigned for selection
        d - SSM Disabled      x - Peer timed out      i - Init state
        s - Output squelched

Fl  Interface                QLrcv  QLuse  Pri  QLsnd  Output driven by
==== =====
>S  HundredGigE0/0/0/13      ePRTC ePRTC  31  ePRTC  HundredGigE0/0/0/18
>S  HundredGigE0/0/0/18      ePRTC ePRTC  30  DNU    HundredGigE0/0/0/18
RP/0/RP0/CPU0:Shadowtower#sh frequency synchronization selection
Node 0/RP0/CPU0:
=====
Selection point: T0-SEL-B (3 inputs, 1 selected)
  Last programmed 02:41:55 ago, and selection made 02:41:04 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
  Used for local clock interface output
  S  Input                Last Selection Point          QL  Pri  Status
  == =====
  33 HundredGigE0/0/0/18  0/RP0/CPU0 ETH_RXMUX 33  ePRTC  30  Locked
    HundredGigE0/0/0/13  0/RP0/CPU0 ETH_RXMUX 22  ePRTC  31  Available
    Internal0 [0/RP0/CPU0] n/a                          SEC   255  Available

Selection point: 1588-SEL (3 inputs, 1 selected)
  Last programmed 02:41:55 ago, and selection made 02:41:04 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  Internal0 [0/RP0/CPU0] n/a                          SEC   255  Freerun
    HundredGigE0/0/0/18  0/RP0/CPU0 ETH_RXMUX 33  ePRTC  30  Available
    HundredGigE0/0/0/13  0/RP0/CPU0 ETH_RXMUX 22  ePRTC  31  Available

Selection point: CHASSIS-TOD-SEL (1 inputs, 1 selected)
  Last programmed 02:41:44 ago, and selection made 02:41:44 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  HundredGigE0/0/0/18  0/RP0/CPU0 T0-SEL-B 33  100  No   Available

```

```

Selection point: ETH_RXMUX (2 inputs, 2 selected)
Last programmed 02:41:55 ago, and selection made 02:41:55 ago
Next selection points
  SPA scoped      : None
  Node scoped     : T0-SEL-B 1588-SEL
  Chassis scoped  : None
  Router scoped   : None
Uses frequency selection
S  Input                               Last Selection Point           QL  Pri  Status
==  =====
33 HundredGigE0/0/0/18                 n/a                             ePRTC 30 Available
22 HundredGigE0/0/0/13                 n/a                             ePRTC 31 Available

```

Verifying the Frequency Synchronization Configuration

After performing the frequency synchronization configuration tasks, use this task to check for configuration errors and verify the configuration.

1. show frequency synchronization selection

```

RP/0/RP0/CPU0:R5# show frequency synchronization selection
Fri Apr 24 12:49:32.833 UTC
Node 0/RP1/CPU0:
=====
Selection point: T0-SEL-B (3 inputs, 1 selected)
Last programmed 3d04h ago, and selection made 3d04h 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
==  =====
4  HundredGigE0/7/0/0                 0/RP1/CPU0 ETH_RXMUX 4           PRC  10  Locked
   PTP [0/RP1/CPU0]                   n/a                             PRC  254 Available
   Internal0 [0/RP1/CPU0]              n/a                             SEC  255 Available

Selection point: 1588-SEL (2 inputs, 1 selected)
Last programmed 3d04h ago, and selection made 3d04h 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
==  =====
4  HundredGigE0/7/0/0                 0/RP1/CPU0 ETH_RXMUX 4           PRC  10  Locked
   Internal0 [0/RP1/CPU0]              n/a                             SEC  255 Available

Selection point: CHASSIS-TOD-SEL (2 inputs, 1 selected)
Last programmed 3d04h ago, and selection made 3d04h 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/RP1/CPU0]          n/a          100 Yes Available
  HundredGigE0/7/0/0       0/RP1/CPU0 T0-SEL-B 4 100 No Available

```

```

Selection point: ETH RXMUX (1 inputs, 1 selected)
Last programmed 3d04h ago, and selection made 3d04h ago

```

```

Next selection points
  SPA scoped   : None
  Node scoped  : T0-SEL-B 1588-SEL
  Chassis scoped: None
  Router scoped: None

```

```

Uses frequency selection

```

```

S Input          Last Selection Point      QL Pri Status
== =====
4 HundredGigE0/7/0/0 n/a          PRC 10 Available

```

2. show frequency synchronization configuration-errors

```

RP/0/RP0/CPU0:router# show frequency synchronization configuration-errors

```

```

Node 0/2/CPU0:

```

```

=====

```

```

interface GigabitEthernet0/2/0/0 frequency synchronization
 * Frequency synchronization is enabled on this interface, but isn't enabled globally.
interface GigabitEthernet0/2/0/0 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.
- 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.

3. show frequency synchronization interfaces brief

```

RP/0/RP0/CPU0:R5# show frequency synchronization interfaces brief

```

```

Flags: > - Up

```

```

      d - SSM Disabled
      s - Output squelched

```

```

Fl Interface

```

```

D - Down          S - Assigned for selection

```

```

x - Peer timed out  i - Init state

```

```

Last Selection Point

```

```

Pri Time

```

```

Status

```

```

          QLrcv QLuse Pri QLsnd Output driven by
=====
>S TenGigE0/0/0/0 PRC PRC 1 DNU TenGigE0/0/0/0
>x TenGigE0/0/0/1 Fail n/a 100 PRC TenGigE0/0/0/0
>x TwentyFiveGigE0/0/0/30 Fail n/a 100 PRC TenGigE0/0/0/0

```

```

RP/0/RP0/CPU0:R5#

```

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.

4. show processes fsyncmgr location node-id

This command verifies that the fsyncmgr process is running on the appropriate nodes.

```
RP/0/RP0/CPU0:R5# show processes fsyncmgr location 0/0/CPU0
Thu Feb 1 06:26:32.979 UTC
Job Id: 181
PID: HYPERLINK "tel:3411"3411
Process name: fsyncmgr
Executable path:
/opt/cisco/XR/packages/ncs540-iosxr-fwding-1.0.0.0-r63226I/all/bin/fsyncmgr Instance #:
 1
Version ID: 00.00.0000
Respawn: ON
Respawn count: 1
Last started: Tue Jan 23 04:26:57 HYPERLINK "tel:2018"2018
Process state: Run
Package state: Normal
core: MAINMEM
Max. core: 0
Level: 100
Placement: None
startup_path:
/opt/cisco/XR/packages/ncs540-iosxr-fwding-1.0.0.0-r63226I/all/startup/fsyncmgr.startup
Ready: 2.063s
Process cpu time: 168.480 user, 129.980 kernel, 298.460 total
JID TID Stack pri state NAME rt_pri
181 HYPERLINK "tel:3411"3411 OK 20 Sleeping fsyncmgr 0
181 HYPERLINK "tel:3572"3572 OK 20 Sleeping lwm_debug_threa 0
181 HYPERLINK "tel:3573"3573 OK 20 Sleeping fsyncmgr 0
181 HYPERLINK "tel:3574"3574 OK 20 Sleeping lwm_service_thr 0
181 HYPERLINK "tel:3575"3575 OK 20 Sleeping qsm_service_thr 0
181 HYPERLINK "tel:3622"3622 OK 20 Sleeping fsyncmgr 0
181 HYPERLINK "tel:3781"3781 OK 20 Sleeping fsyncmgr 0
181 HYPERLINK "tel:3789"3789 OK 20 Sleeping fsyncmgr 0
```

Verifying the ESMC Configuration

show frequency synchronization interfaces

```
Router# show frequency synchronization interfaces
Interface TenGigE0/0/0/0 (up)
```



```

Assigned as input for selection
Wait-to-restore time 0 minutes
SSM Enabled
Peer Up for 2d01h, last SSM received 0.320s ago
Peer has come up 1 times and timed out 0 times
ESMC SSMs Total Information Event DNU/DUS
Sent: HYPERLINK "tel:178479"178479 HYPERLINK "tel:178477"178477 2 HYPERLINK "tel:178463"178463

Received: HYPERLINK "tel:178499"178499 HYPERLINK "tel:178499"178499 0
0
Input:
Up
Last received QL: Opt-I/PRC
Effective QL: Opt-I/PRC, Priority: 1, Time-of-day Priority 100
Supports frequency
Output:
Selected source: TenGigE0/0/0/0
Selected source QL: Opt-I/PRC
Effective QL: DNU
Next selection points: ETH_RXMUX
Interface TenGigE0/0/0/1 (up)
Wait-to-restore time 5 minutes
SSM Enabled
Peer Timed Out for 2d01h, last SSM received never
Peer has come up 0 times and timed out 1 times
ESMC SSMs Total Information Event DNU/DUS
Sent: HYPERLINK "tel:178479"178479 HYPERLINK "tel:178477"178477 2 0
Received: 0 0 0 0
Input:
Down - not assigned for selection
Supports frequency
Output:
Selected source: TenGigE0/0/0/0
Selected source QL: Opt-I/PRC
Effective QL: Opt-I/PRC
Next selection points: ETH_RXMUX
Interface TwentyFiveGigE0/0/0/30 (up)
Wait-to-restore time 5 minutes
SSM Enabled
Peer Timed Out for 01:50:24, last SSM received 01:50:30 ago
Peer has come up 1 times and timed out 1 times
ESMC SSMs Total Information Event DNU/DUS
Sent: HYPERLINK "tel:75086"75086 HYPERLINK "tel:75085"75085 1 0
Received: HYPERLINK "tel:68457"68457 HYPERLINK "tel:68455"68455 2 HYPERLINK "tel:68443"68443
Input:
Down - not assigned for selection
Supports frequency
Output:
Selected source: TenGigE0/0/0/0
Selected source QL: Opt-I/PRC
Effective QL: Opt-I/PRC
Next selection points: ETH_RXMUX

```

Verifying Controllers Timing LEDs

```

Router# show controllers timing led status location 0/RP0/CPU0
LED Status:
BITS0: Off
BITS1: Off
Sync: Green
GNSS: Off
GPS: NA

```




CHAPTER 14

Transparent PDH over Packet (TPoP) and Channelized SDH over Packet (CSoP)

Transparent PDH over Packet (TPoP) Smart SFP converts E1 traffic to a packet stream using TDM over packet pseudo-wire technology. TPoP Smart SFP can be used on selected SFP slots in a router to transport PDH traffic across a packet network. TPoP Smart SFP is a plug-and-play device which can be used without any provisioning and simplifies configuration and service turn-up of E1 connections across a packet network. The integration of TPoP into an SFP greatly reduces system and network complexity, offers lower carbon footprint, and results in savings.

Channelized SDH over Packet (CSoP) Smart SFP converts a fully channelized SDH signal to a packet stream using TDM over packet pseudo-wire technology. CSoP Smart SFP can replace an existing SFP in a router or a switch and transport E1 traffic across a packet network. CSoP Smart SFP aggregates single E1 and enables each E1 channel to be processed individually to provide a high-density gateway between an SDH network and a TDM over packet ethernet or IP or MPLS network.

Following are the supported E1 and STM1 optical SFPs, for more information on the supported router variants based on the release versions, see [Cisco Optics-to-Device Compatibility Matrix](#).

- Framed STM1-ch E1 type: SFP-CH-OC3STM1-I
- Framed PDH E1 type: SFP-E1F-SATOP-I
- [Configuring TPoP and CSoP, on page 205](#)
- [VPWS with Smart SFP, on page 208](#)
- [Multi Router Automatic Protection Switching, on page 208](#)
- [Field-Pluggable Device \(FPD\) Version Upgrade for Smart SFP, on page 209](#)
- [Restrictions for Smart SFP, on page 212](#)

Configuring TPoP and CSoP

Consider a deployment scenario with the TDM circuits from a base transceiver station is connected to an access router and must be transported to the base station controller through an aggregation router over an MPLS network through pseudowire.

During aggregation from transceiver to controller, the TDM circuits protect the data by using smart SFPs. For the E1 lines coming from transceiver, you must use TPoP SFPs and for the STM-1 lines coming from transceiver or controller, you must use CSoP SFPs.

You can monitor the alarms and performances on TPoP and CSoP smart SFPs.

Table 21: Support on E1 Transmission

Feature	E1 Framed
SATOP	Supported
Clock configuration	ACR, DCR, internal, Line
BERT - System/Line	Supported (Inverted-PRBS15)
PM -E1	SELS, LES, UAS, LCV, PCV Far End counters are NOT SUPPORTED
Alarms	LOS, AIS, LOF, RDI
Loopback - (local / line)	Supported
CEM counters	Supported

Table 22: Support on OC3-STM1 Transmission

Feature	OC3-STM1
E1 SATOP	STM-1 Channelized E1
Clock Configuration on Channelised-E1	ACR, DCR, internal, Line
E1 Channel BERT - System/Line channel prbs	Supported (Inverted-PRBS15)
PM-STM1 RS/MS	ES, SES, UAS Far End counters are NOT SUPPORTED
Threshold and its alerts	Supported
Alarms STM1	LOS, LOF, RS-TIM, MS-AIS, MS-RAI

Also consider a case, with Automatic Protection Switching (APS) protection being enabled on the controller, then the protect link coming from a single node or from multiple nodes with standby pseudowire is supported in the MPLS core.

Configuring Controller for PDH E1

To configure PDH E1 on a controller, ensure the Gigabit Ethernet port is up and enter the following commands:

```
enable
configure terminal
    controller e1 0/0/0/7
    vlan 100 ecid 1
end
```

You must mention a unique VLAN ID which is specific to that port and ecid number to identify E1.

Verifying Controller for PDH E1

Use the **show controller e1 x/y/z** command to verify the controller configuration on E1 for TPoP smart SFP.

```

Router# show controller e1 0/0/0/7
Controller State: Up
Transport Admin State: In Service
Framing: Unframed
Linecoding: High Density Bipolar Order 3
Loopback: None
Clock: Adaptive Clock Recovery (ACR)
Clock State: Locked
VLAN ID: 100
ecid:1

```

Configuring Controller for STM1

To configure STM1 on a controller, ensure the Gigabit Ethernet port is up and enter the following commands:

```

controller STM1 0/0/0/18
  aug-mapping au4 au-4 1
  mode tug3
    tug-3 1
    mode tug2
      tug-2 1 payload vc12
      vc12 1 mapping e1

/*Configure STM1-ch E1 */

```

Verifying Controller for STM1

Use the **show controller stm1 x/y/z** command to verify the controller configuration on STM1 for CSoP smart SFP.

```

Router# show controller STM1 0/0/0/18
Port STM 10/0/0/18

Status:
Primary State: Up
Configured Sec admin State: Normal
Inherited Sec admin State: Normal
Derived State: In Service
performance_monitoring_enabled
Loopback: None

```

Configuring Controller for STM1-ch E1

To configure each E1 on STM1 port, enter the following commands:

```

Config terminal
  controller E1 0/0/0/18/1/1/1/1
  vlan 200 ecid 1

```

You can configure the same VLAN ID for all the E1 under the same STM1 port or a different VLAN ID for each E1 under that STM1 port.

Verifying Controller for STM1-ch E1

Use the **show controller e1 x/y/z** command to verify the controller configuration on STM1.

```

Router# show controller e1 0/0/0/18/1/1/1/1
Controller State: Up
Transport Admin State: In Service

```

```

Framing: Unframed
Linecoding: None
Loopback: None
Clock: Internal

```

```

VLAN ID: 200
ecid:1

```

VPWS with Smart SFP

The TDM circuits flows through the VPWS with smart SFP packetizing the incoming TDM frames. Packetizing happens with the following process:

- All frames from the TDM lines are channelized until E1 and then packetized.
- The packetization is done by adding:
 - RTP header – For DCR clocking support
 - VLAN header – For uniquely identifying the E1 channel
 - ENET header – The Ethernet DMAC and SMAC
 - CW – control word for communicating the sequence number, faults in the access side
 - Payload – the incoming TDM frames are chopped into 193Bytes frames and added into the payload.
 - The packets mentioned previously sent to the NPU.
- The E1 channel is mapped into a sub-interface (with specific VLAN).
- The packets received into the NPU with that specific VLAN number go through the VPWS logic and gets pseudowired (xconnected) with the configuration in a specific sub-interface.
- QOS configured under the sub-interface gets applied to this PW.

Multi Router Automatic Protection Switching

The Multi Router Automatic Protection Switching (MR-APS) integration with hot standby pseudowire (HSPW) feature is a protection mechanism for SDH to switch to another circuit during failure.

Consider a deployment scenario with the MR-APS circuits from a base transceiver station is connected to access router and must be transported to the base station controller through an aggregation router over an MPLS network through pseudowire. When the pseudowire reaches the router with MR-APS, data is depacketized on the smart SFP and the raw TDM frames are sent towards the base station controller. The controller is connected to routers via two links, one as working link from router-A and other as protect link towards the router-B.

Configuring Xconnect on Sub-Interface

To configure E1 port based on the VLAN ID, create sub-interface Gigabit Ethernet port.



Note The **propagate-tdm-alarm** command enables the forwarding of port level alarms to Gigabit Ethernet port in which Smart SFP resides.

```

Config terminal
controller STM1 0/0/0/0
    propagate-tdm-alarm
!
interface GigabitEthernet0/0/0/18.200 l2transport
    encapsulation dot1q 200
!

interface GigabitEthernet0/0/0/7.100 l2transport
    encapsulation dot1q 100

l2vpn
pw-class tdm_pw
    encapsulation mpls
!
!
xconnect group tdm_csop
p2p pw200
    interface GigabitEthernet0/0/0/18.200
    neighbor ipv4 2.2.2.2 pw-id 200
    pw-class tdm_pw
!
!
!
xconnect group tdm_tpop
p2p pw100
    interface GigabitEthernet0/0/0/7.100
    neighbor ipv4 2.2.2.2 pw-id 100
    pw-class tdm_pw
!
!
!

```

For more information on the standby pseudowire, see *Configure Pseudowire Redundancy* in chapter *Configure Point-to-Point Layer 2 Services* of the *L2VPN and Ethernet Services Configuration Guide*.

Field-Pluggable Device (FPD) Version Upgrade for Smart SFP



Note The following steps are applicable to Channelized SDH over Packet (CSoP) STM-1 SFPs and E1 Transparent PDH over Packet (TPoP) SFPs only.

Before you begin

To upgrade the FPD version on the Cisco NCS 5500 Series Routers, perform the following steps:

1. To check the existing version of the FPD, run the **show hw-module fpd** command.

Sample output for checking the current FPD version:

```

RP/0/RP0/CPU0:router# show hw-module fpd

Thu Dec 15 06:47:08.068 UTC

Auto-upgrade:Disabled

                                FPD Versions
                                =====
Location   Card type                HWver FPD device        ATR Status   Running   Programd
-----
0/0/1      NC55-MPA-4H-S            1.0   MPAPPGA             CURRENT      0.54      0.54
0/RP0      NCS-55A2-MOD-HD-S       1.0   MB-MIFPGA           NEED UPGD   0.19      0.19
0/RP0      NCS-55A2-MOD-HD-S       1.0   SSFP_E1F_12         NEED UPGD 7.01    7.01
0/RP0      NCS-55A2-MOD-HD-S       1.0   SSFP_E1F_13         CURRENT     13.01     13.01
0/RP0      NCS-55A2-MOD-HD-S       1.0   SSFP_E1F_17         NEED UPGD   7.01      7.01
0/RP0      NCS-55A2-MOD-HD-S       1.0   SSFP_OC3_STM1_0     CURRENT     12.01     12.01
0/RP0      NCS-55A2-MOD-HD-S       1.0   Bootloader           CURRENT     1.18      1.18
0/RP0      NCS-55A2-MOD-HD-S       1.0   CPU-IOFPGA           CURRENT     1.27      1.27
0/RP0      NCS-55A2-MOD-HD-S       1.0   MB-IOFPGA            NEED UPGD   0.18      0.18
0/RP0      NCS-55A2-MOD-HD-S       1.0   SATA-M500IT-MU-A    CURRENT     5.00      5.00
0/PM0      NC55-900W-ACFW-HD       256.0 LIT-PrimCU-ACFW-I   CURRENT     1.04      1.04
0/PM1      NC55-900W-ACFW-HD              LIT-PrimCU-ACFW-I   NOT READY

```

- To upgrade the hardware, run the **upgrade hw-module location 0/RP0 fpd <> force** command.

To check the status of upgrade, run the **show hw-module fpd** command until the upgrade progress reaches 100 percent. The following are sample outputs for checking the status of the upgrade:

```

RP/0/RP0/CPU0:router# show hw-module fpd

Wed Dec 14 07:08:08.424 UTC

Auto-upgrade:Disabled

                                FPD Versions
                                =====
Location   Card type                HWver FPD device        ATR Status   Running   Programd
-----
0/RP0      NCS-55A2-MOD-HD-S       0.5   MB-MIFPGA             CURRENT      0.05      0.05
0/RP0      NCS-55A2-MOD-HD-S       1.0   SSFP_E1F_12           30% UPGD 13.01
0/RP0      NCS-55A2-MOD-HD-S       1.0   SSFP_E1F_4            CURRENT     13.01     13.01
0/RP0      NCS-55A2-MOD-HD-S       1.0   SSFP_STM1_TSOP_1     CURRENT     13.00     13.00
0/RP0      NCS-55A2-MOD-HD-S       0.5   Bootloader            NEED UPGD   1.14      1.14
0/RP0      NCS-55A2-MOD-HD-S       0.5   CPU-IOFPGA            NEED UPGD   0.07      0.07
0/RP0      NCS-55A2-MOD-HD-S       0.5   MB-IOFPGA             NEED UPGD   0.23      0.23
0/RP0      NCS-55A2-MOD-HD-S       0.5   SATA-M500IT-MU-B     CURRENT     4.00      4.00

```



```
RP/0/RP0/CPU0:router# show hw-module fpd

Wed Dec 14 07:08:08.424 UTC

Auto-upgrade:Disabled

                                FPD Versions
                                =====
Location   Card type                HWver FPD device    ATR Status    Running    Programd
-----
0/RP0      NCS-55A2-MOD-HD-S        0.5  MB-MIFPGA          CURRENT      0.05      0.05
0/RP0      NCS-55A2-MOD-HD-S        1.0  SSFP_E1F_12        75% UPGD    13.01
0/RP0      NCS-55A2-MOD-HD-S        1.0  SSFP_E1F_4         CURRENT      13.01      13.01
0/RP0      NCS-55A2-MOD-HD-S        1.0  SSFP_STM1_TSOP_1   CURRENT      13.00      13.00
0/RP0      NCS-55A2-MOD-HD-S        0.5  Bootloader         NEED UPGD    1.14      1.14
0/RP0      NCS-55A2-MOD-HD-S        0.5  CPU-IOFPGA         NEED UPGD    0.07      0.07
0/RP0      NCS-55A2-MOD-HD-S        0.5  MB-IOFPGA          NEED UPGD    0.23      0.23
0/RP0      NCS-55A2-MOD-HD-S        0.5  SATA-M500IT-MU-B   CURRENT      4.00      4.00
```

- Step 1** After the Smart SFP FPD upgrade completes 100 percent or after receiving the upgrade success message, wait for 15 seconds.
- Step 2** Perform an online insertion and removal (OIR) of the Smart SFP:
- Remove the Smart SFP and wait for two minutes for the clean-up to complete.
 - Insert the Smart SFP on the same port.
- This step recreates the controller with all its configurations.
- Step 3** To verify the Smart SFP version, run the **show hw-module fpd** command.

Example

Sample command output for checking the FPD version of the Smart SFP:

```
RP/0/RP0/CPU0:router# show hw-module fpd

Wed Dec 14 07:08:08.424 UTC

Auto-upgrade:Disabled

                                FPD Versions
                                =====
Location   Card type                HWver FPD device    ATR Status    Running    Programd
-----
0/RP0      NCS-55A2-MOD-HD-S        0.5  MB-MIFPGA          CURRENT      0.05      0.05
0/RP0      NCS-55A2-MOD-HD-S        1.0  SSFP_E1F_12        CURRENT      13.01      13.01
0/RP0      NCS-55A2-MOD-HD-S        1.0  SSFP_E1F_4         CURRENT      13.01      13.01
0/RP0      NCS-55A2-MOD-HD-S        1.0  SSFP_STM1_TSOP_1   CURRENT      13.00      13.00
0/RP0      NCS-55A2-MOD-HD-S        0.5  Bootloader         NEED UPGD    1.14      1.14
0/RP0      NCS-55A2-MOD-HD-S        0.5  CPU-IOFPGA         NEED UPGD    0.07      0.07
0/RP0      NCS-55A2-MOD-HD-S        0.5  MB-IOFPGA          NEED UPGD    0.23      0.23
0/RP0      NCS-55A2-MOD-HD-S        0.5  SATA-M500IT-MU-B   CURRENT      4.00      4.00
```

Restrictions for Smart SFP



Warning If MR-APS is configured on the SFP, then remove MR-APS configuration before you remove the SFP from the port.

- CEM interface configuration isn't supported.
- E1 emulation is supported only on Ethernet pseudowire (VPWS).
- CSoP doesn't support E1-AIS alarm.
- No support to Single Router–Automatic Protection Switching (SR-APS)
- CLI configuration for the E1 controller on a VLAN needs to be mapped to an Ethernet sub-interface (by configuring same VLAN dot1q under the sub-interface). Any xconnect, also must be configured with this ethernet sub-interface.
- Multi Router-Automatic Protection Switching (MR-APS) is supported only by using the VLAN PW.
- Ensure that you have more than one MPLS paths, in core to convergence during core failure scenario.
- Only 8 smart SFPs are supported per router.
- ACR clocking is not supported in TPoP and CSoP unframed SFPs. Only framed to framed connection is supported, so not supported on framed to unframed connections.
- STM1 CSoP:
 - E1 Level shutdown is not supported.
 - Controller shutdown won't inject AIS but injects only LOS towards CE.
 - Bit error rate test (BERT) can be run only on one E1 channelized controller.
- CSoP and TPoP:
 - 25G ports are not supported.
 - Bit error rate is not supported.
- SF or SD threshold is not supported.
- Only 16-byte J0 is supported.
- BERT is not supported in unframed SFP.
- Loopback is supported only on, one of the 63 channels of CSoP SFP.
- Configuration with same ECID for CSoP E1s is not supported. ECID must be unique for each E1 under CSoP.
- The **show alarm conditions** command is not supported in Release 7.5.1.
- High convergence of 100ms is observed for MR-APS for LOS based switchover (for CSoP E1s).

- With smart SFP, high convergence of 4-6 minutes is observed in MR-APS for router reload based switchover.
- CSoP loopback on framed STM1-ch E1 doesn't work over **reload warm** command with smart SFP. Applicable only in Release 7.5.1.
- FPD upgrade is not supported for smart SFP. .
- LCV counter updates are not supported for smart SFP.



CHAPTER 15

Configuring Smart Licensing

This module describes the configuration related to the Smart Licensing.

Table 23: Feature History for Smart License

Release	Modification
Release 6.3.2	Smart Licensing was introduced.
Release 6.5.2	Flexible Consumption License Model was introduced.
Release 7.4.1	YANG Data Models for Smart Licensing was introduced.

This module contains the following topics:

- [What is Smart Licensing?, on page 215](#)
- [What is Flexible Consumption Model?, on page 216](#)
- [How Does Smart Licensing Work?, on page 225](#)
- [What is Cisco Smart Software Manager?, on page 227](#)
- [YANG Data Models for Smart Licensing, on page 229](#)
- [Configuring Smart Licensing, on page 231](#)
- [Registering and Activating Your Router, on page 239](#)
- [Verifying the Smart Licensing Configuration , on page 244](#)
- [Specific License Reservation, on page 252](#)
- [Configuring Specific License Reservation, on page 253](#)
- [To cancel, verify, remove, and return SLR, on page 255](#)
- [Configuration Examples for SLR, on page 257](#)

What is Smart Licensing?

Smart Licensing is a cloud-based, flexible software licensing model that enables you to activate and manage Cisco software licenses across their organization. Smart Licensing solution allows you to easily track the status of your license and software usage trends. Cisco Smart Licensing establishes a pool of licenses or entitlements that can be used across the entire organization in a flexible and automated manner. Smart Licensing helps simplify four core functions:

- **Purchase**—Creates a Smart Account (and optionally, your Virtual Account). Licenses are added to your Smart Account and are immediately available for use.
- **Install**—Register your product with your Smart Account using an account-based Registration Token. Thereafter, the entire process is automatic. Product Activation Keys (PAKs) and license files are no longer needed.
- **Management**—Make changes to license consumption by updating your configuration; any license change is automatically reflected in your Smart Account. You can share licenses in your Virtual Account through the license pooling option. License pools (logical grouping of licenses) can reflect your organization structure. Smart Licensing solution also offers Cisco Smart Software Manager, a centralized portal that enables you to manage all your Cisco software licenses from one centralized website.
- **Visibility and Asset Management**—Cisco Smart Software Manager (CSSM) portal offers an integrated view of the licenses you own and have deployed. You can use this data to make better purchase decisions, based on your consumption.

What is Flexible Consumption Model?

Table 24: Feature History Table

Feature Name	Release Information	Feature Description
Flexible Consumption Model on NC57-48Q2D-S and NC57-48Q2D-SE-S	Release 7.10.1	Flexible Consumption Model on NC57-48Q2D-S and NC57-48Q2D-SE-S Line cards.
Flexible Consumption Model on NCS-57D2-18DD-SYS	Release 7.8.1	Flexible Consumption Model (FCM) is now extended to the NCS-57D2-18DD-SYS chassis.
FCM Licensing on the line cards: <ul style="list-style-type: none"> • NCS-57C3-MOD • NCS-57C3-MODS • NC57-36H6D-LC 	Release 7.4.1	Support for FCM licensings is extended to the following line cards: <ul style="list-style-type: none"> • NCS-57C3-MOD • NCS-57C3-MODS • NC57-36H6D-LC
Essential and Advantage smart licenses in a combined entitlement	Release 7.4.1	With this release, the Advanced licenses are now referred to as the Advantage licenses, without essential entitlement. Also, a new license model – Advantage with Essentials, has been introduced that contains both Essential and Advantage licenses as a combined entitlement in a single PID. This simplifies the license procurement and management effort by eliminating the need to procure separate PIDs for Essential and Advantage licenses.

Feature Name	Release Information	Feature Description
Support for Flexible Consumption Model (FCM) licensing on the chassis NCS-57B1-6D24-SYS and NCS-57B1-5DSE-SYS.	Release 7.3.1	Support for FCM licensing is now extended to the following chassis: <ul style="list-style-type: none"> • NCS-57B1-6D24-SYS • NCS-57B1-5DSE-SYS

The Flexible Consumption Model (FCM) provides the capability and flexibility to purchase software capacity as needed. FCM delivers the following:

- Pay-as-you-grow—Enables you to lower initial costs and add more capacity over time.
- Simplify operations—FCM delivers the carrier-class IOS-XR software feature set with two software suites, Essentials and Advantage, that simplifies license management.
- Utilize capital efficiently—License pooling enables an efficient way to share licenses across the network.

The types of licenses in this model are:

- Essential Licenses are the base licenses that are required by every active port for its operation. An example of Essential License is ESS-100G-RTU-1.
- Advantage (earlier known as Advanced licenses) without essential licenses, are the licenses that are required on top of Essential Licenses for ports that use advanced features like L3VPN. An example of an advantage license is ADV-400G-RTU-1.
- Advantage with Essential combination licenses are the licenses that are packaged together as a combined entitlement. Example of an advantage license with essentials is ADN-100G-RTU-1.
- Tracking licenses, for example NCS-5501-TRK.

To enable Flexible Consumption model licensing on routers running Cisco IOS XR :

```
Router(config)# license smart flexible-consumption enable
Router(config)# commit
```

Alternatively, you can use the YANG data model `Cisco-IOS-XR-smart-license-cfg` to enable FCM:

```
<rpc xmlns="urn:ietf:params:xml:ns:netconf:base:1.0" message-id="101">
  <get-config>
    <source>
      <running/>
    </source>
    <filter>
      <licensing xmlns="http://cisco.com/ns/yang/Cisco-IOS-XR-smart-license-cfg">
        <flex-consumption/>
      </licensing>
    </filter>
  </get-config>
</rpc>
```

To verify the Flexible Consumption Model configuration:

```
Device# show running-config license smart flexible-consumption enable
```

The following tables provide information about FCM licenses for NCS 5500 and NCS 5700 Series routers:

Table 25: Flexible Consumption Model Licensing Usage Pattern

License Name	Hardware Supported	Consumption Pattern
Essential Licenses: <ul style="list-style-type: none"> • ESS-100G-RTU-1 • ESS-400G-RTU-1 Advantage Licenses: <ul style="list-style-type: none"> • ADV-100G-RTU-1 • ADV-400G-RTU-1 	<ul style="list-style-type: none"> • Routers with fixed chassis unit: NCS-5501-SYS, NCS-5501-SE-SYS, NCS-5502-SYS, NCS-5502-SE-SYS, NCS-55A1-24H-SYS, NCS-55A1-36H-S-SYS, NCS-55A2-MOD-HD-S-SYS, NCS-55A2-MOD-SE-S-SYS, NCS-55A2-MOD-S-SYS, NCS-55A1-36H-SE-S-SYS, NCS-55A1-48Q6H-SYS, NCS-55A1-24Q6H-SS-SYS, NCS-57B1-6D24-SYS, and NCS-57B1-5DSE-SYS • Routers with modular chassis unit: NCS-5504-SYS, NCS-5508-SYS, NCS-5516-SYS • Line cards: NC-57-18DD-SE, NC-57-24DD, NC-55-32T16Q4H-A, NC-57-36H-SE, NC-55-36X100G, NC-55-36X100GA-SE, NC-55-18H18F, NC-55-24H12F-SE, NC-55-24X100G-SE, NC-55-6X200-DWDM-S, NC-55-MOD-A-S, NC-55-MOD-A-SE-S, and NC-55-36X100G-S 	The number of essential or advantage licenses that are consumed depends on the number of active ports and is reported on per chassis basis.

License Name	Hardware Supported	Consumption Pattern
<p>Hardware Tracking Licenses that support chassis:</p> <ul style="list-style-type: none"> • NCS-5501-TRK • NCS-5501-SE-TRK • NCS-5502-TRK • NCS-5502-SE-TRK • NCS-5504-TRK • NCS-5508-TRK • NCS-5516-TRK • NCS-55A1-24H-TRK • NCS-55A1-36H-TRK • NCS-55A1-36HS-TRK • NCS-55A1-48Q6H-TRK • NCS-55A2-MOD-TRK • NCS-55A2-MODH-TRK • NCS-55A2-MODS-TRK • NCS-55A1-24Q6-TRK • NCS-55A1-24QX-TRK • NC55-32T16Q-LC-TRK • NCS-57B1-6D24-SYS • NCS-57B1-5DSE-SYS • NCS_57D2_18DD_TRK 	<p>These Tracking licenses are named on the basis of the hardware supported. For example, NCS-5501-TRK licenses support NCS 5501 systems.</p>	<p>The number of licenses that are consumed depends on the number of chassis in use.</p>

License Name	Hardware Supported	Consumption Pattern
<p>Hardware Tracking Licenses that support line cards:</p> <ul style="list-style-type: none"> • NC55-36H-LC-TRK • NC55-36HSE-LC-TRK • NC55-18HF-LC-TRK • NC55-24H12-LC-TRK • NC55-24HSE-LC-TRK • NC55-DWDM-LC-TRK • NC55-MOD-A-SE-TRK • NC55-MOD-A-TRK • NC55-36HS-LC-TRK • NC55-18D12TH SE-LC-TRK • NC55-24D-LC-TRK • NCS-57C3-MOD-TRK • NCS-57C3-MODS-TRK • NC57-36H6D-LC-TRK 	<p>These Tracking licenses are named on the basis of the line card supported. For example, NC55-36H-LC-TRK licenses support NC-55-36X100G line cards.</p>	<p>The number of licenses that are consumed depends on the number of line cards in use.</p>

Table 26: Advantage with Essential Licenses

License Product ID	License Entitlement	License Description
ADN-100G-RTU-1	1 ESS RTU Tag + 1 ADV RTU Tag	Core & Aggregation Advantage with Essentials SW RTU v1.0 100G
ADN-100G-RTU-2	1 ESS RTU Tag + 1 ADV RTU Tag	Core & Aggregation Advantage with Essentials SW RTU v2.0 100G
ADN-100G-SIA-3	1 ESS SIA 3 Tag + 1 ADV SIA 3 Tag	Core & Aggr Advantage with Essentials SIA 100G 3-5 year term
ADN-100G-SIA-5	1 ESS SIA 3 Tag + 1 ADV SIA 3 Tag	Core & Aggr Advantage with Essentials SIA 100G 5-10 year term
ADN-100G-SIA-ST	1 ESS SIA 3 Tag + 1 ADV SIA 3 Tag	Core & Aggr Advantage with Essentials SIA 100G 1-35 month term
ESS-100G-RTU-2	1 ESS RTU Tag	Core & Aggregation Essentials SW Right-to-Use v2.0 per 100G

License Product ID	License Entitlement	License Description
ESS-ADN-100G-SIA3	1 ADV SIA 3 Tag	Core & Agg Essentials to Advantage Upgrade SIA 100G 3-5 yrs
ESS-ADN-100G-SIA5	1 ADV SIA 3 Tag	Core & Agg Essentials to Advantage Upgrade SIA 100G 5-10 yrs
ESS-ADN-100G-SIAST	1 ADV SIA 3 Tag	Core & Agg Essentials to Advantage Upgrade SIA 100G 1-35 month term
ESS-ADN-100G-RTU2	1 ADV RTU Tag	Core & Agg Essentials to Advantage Upgrade RTU v2.0 100GE
ESS-ADN-100G-RTU1	1 ADV RTU Tag	Core & Agg Essentials to Advantage Upgrade RTU v1.0 100GE

Software Innovation Access

Table 27: Feature History Table

	Release Information	Feature Description
Software Innovation Access (SIA) Entitlement	Release 7.3.1	SIA license grants you access to the latest software upgrades which contain new features, bug fixes, and security enhancements for devices on your network. Also, it enables the consumption of Advantage and Essential Right-to-Use (RTU) licenses on your device, and allows portability of these RTU licenses from one device to another.

Overview

Software Innovation Access (SIA) subscription, a type of FCM licensing, provides access to the latest software upgrades and features for your network. SIA licenses enable the consumption of Right-to-Use (RTU) licenses for your devices to access software innovation and avail support for your devices throughout the term of subscription.

The benefits of SIA subscription are:

- **Access to software innovation:** SIA subscription provides access to continuous software upgrades which contain latest features, security enhancements, and bug fixes for all your devices at a network level.

- **Pooling of licenses:** SIA subscription enables Right-to-Use (RTU) licenses to be shared across your FCM network from a common license pool through the virtual account.
- **Protects your investment:** SIA subscription enables the portability of perpetual RTU licenses purchased for your current device to a next-generation router when you expand or upgrade your network.

The initial term of a SIA subscription is for a term of three years. You can renew the subscription by contacting your Cisco account representative. An equal number of SIA licenses and corresponding RTU licenses are required to enjoy the benefits, and ensure that your network is in compliance. There are two types of SIA licenses available:

- : To utilize Advantage RTU licenses, you need Advantage SIA licenses.
- : Essential SIA licenses are required to utilize Essential RTU on your device.

If your device is in a state of SIA Out-of-Compliance (OOC) the benefits cease.

SIA Out-of-compliance (OOC) state

When your device is in a SIA Out-of-compliance state, support for major software version upgrades in your network devices are restricted. However, you can continue to perform minor updates, SMU installations, and RPM installations, and continue to utilize the RTU licenses without support for porting.

A device can get into a SIA Out-of-compliance (OOC) state in the following instances:

- The SIA License *EVAL* period of 90 days has expired.
- The number of SIA licenses consumed has exceeded the number of SIA licenses purchased. This can also occur when the RTU licenses consumed is higher than the number of SIA licenses purchased.
- The term of the SIA license has expired and you haven't renewed the subscription.
- The license authorization status is:
 - Not Authorized: The license authorization code installed doesn't contain sufficient counts for the request. This can occur when you attempt to use more licenses than the licenses available in your Virtual Account.
 - Authorization expired: The device hasn't been able to connect to CSSM for an extended period, due to which the authorization status couldn't be verified.



Note The CSSM smart license hierarchy applies to the Right-to-Use (RTU) license only. Therefore, if there is an insufficient RTU 100G license, CSSM can convert the RTU 400G license into four RTU 100G licenses. This is not applicable for SIA license.

In order to bring your device to In-Compliance state, perform one of the following steps:

- Register your device with CSSM if the SIA license *EVAL* period has expired.
- If the SIA license has expired or the number of SIA licenses consumed is more than the number of SIA licenses purchased, contact your Cisco Account Representative to purchase or renew the required licenses.
- If the authorization code has insufficient counts for the request, generate the code with sufficient counts.
- If the authorization has expired, connect the device with CSSM.

When the device enters an OOC state, a grace period of 90 days (cumulative of all the previous occurrences) begins. During this period, SIA license benefits can still be availed. The system attempts to renew the authorization period by connecting with the CSSM during the grace period, or even after the grace period has expired. If an attempt isn't successful, it remains in an OOC state. If the attempt is successful, a new authorization period begins and the device is In-Compliance.

Verification

To verify the device compliance status, use the **show license platform summary** command:

Examples

Status: In-Compliance

```
Router# show license platform summary
Fri Feb 12 20:33:51.784 UTC
Collection: LAST: Fri Feb 12 2021 20:33:46 UTC
NEXT: Fri Feb 12 2021 20:35:46 UTC
Reporting: LAST: Fri Feb 12 2021 20:33:46 UTC
NEXT: Fri Feb 12 2021 20:35:46 UTC
SIA Status: In Compliance
          Count
Feature/Area Entitlement Last Next
=====
FCM NCS 5500 Core & Agg Netw SW&Autom Ess(100G) 1.0 Per 1 0
FCM Core & Aggr Essentials SIA per 100G 1 0
FCM 5501 SE Base Hardware Tracking PID 1 0
```

Status: Out-of-Compliance (Grace Period Remaining)

```
Router# show license platform summary
Mon Mar 30 04:01:50.405 IST
Collection: LAST: Mon Mar 30 2020 04:01:12 IS
          NEXT: Mon Mar 30 2020 04:02:12 IST
Reporting: LAST: Mon Mar 30 2020 04:01:12 IST
          NEXT: Mon Mar 30 2020 04:03:12 IST
*****IMPORTANT*****
SIA Status: Out of Compliance(Remaining Grace Period: 89 days, 23 hours)
          Number of SIA license(s) used is more than available.
          SW Upgrade will be allowed as SIA Grace Period is remaining
*****
          Count
Feature/Area Entitlement Last Next
=====
FCM NCS 5500 Core & Agg Netw SW&Autom Ess(100G) 1.0 2 0
FCM Essential SIA License 2 0
FCM Total NC-55-18H18F LCs in the system 1 0
FCM 5508 Base Hardware Tracking PID 1 0
```

Status: Out-of-Compliance (Grace Period expired and upgrades are blocked)

```
Router# show license platform summary
Mon Mar 30 04:41:02.036 IST
Collection: LAST: Mon Mar 30 2020 04:40:12 IST
          NEXT: Mon Mar 30 2020 04:41:12 IST
Reporting: LAST: Mon Mar 30 2020 04:39:12 IST
          NEXT: Mon Mar 30 2020 04:41:12 IST
*****IMPORTANT*****
SIA Status: Out of Compliance(Grace Period Expired)
          SW Upgrades are blocked as SIA license(s) are in Not Authorized state
*****
          Count
```

Feature/Area	Entitlement	Last	Next
FCM	NCS 5500 Core & Agg Netw SW&Autom Ess(100G) 1.0	2	2
FCM	Essential SIA License	2	2

Perpetual without SIA Renewal

The Perpetual without Software Innovation Access (SIA) Renewal (PSR) feature enables continued deployment of FCM products after SIA subscriptions have expired, if you choose not to renew the subscription.

PSR reserves Right to Use (RTU) licenses for each device which ensures you can continue to use the RTU license without having corresponding SIA licenses. Deployment of PSR will avoid Out-of-Compliance (OOC) messages after expiry of SIA subscriptions. Though software updates and usage of production SMUs are permitted, major software upgrades are not permitted once PSR is enabled.



- Note**
- You will lose the following benefits of SIA licensing if PSR is enabled:
 - Pooling of Software licenses
 - Software upgrades
 - Investment protection
 - You can deploy PSR only after SIA subscriptions expire.
 - PSR is not available on traditional model of licensing.

PSR Deployment Options

There are two methods for deployment of PSR on your device:

- Cisco EZ-Register

Cisco EZ-Register is a simplified, automated mechanism to register or reserve licenses for multiple devices in your network with Cisco Smart Software Manager (CSSM). It utilizes an input file that is configured by the Network Administrator to execute a script. For more details on using this method, contact your Cisco account representative.

- Manual Deployment

For manual deployment of PSR, you must complete the following steps on your device:

- Enable smart licensing using the **license smart enable** command.
- Configure smart reservation on your device using the **license smart reservation** command.
- Generate a *Reservation request code* using the **license smart reservation request local** command.
- Navigate to your virtual account in the Cisco Smart Software manager (CSSM) tool and enter the *Reservation request code*.
- Select the license and quantity for each of them to be reserved on the device.
- Review the selected details and generate an Authorization code in CSSM.

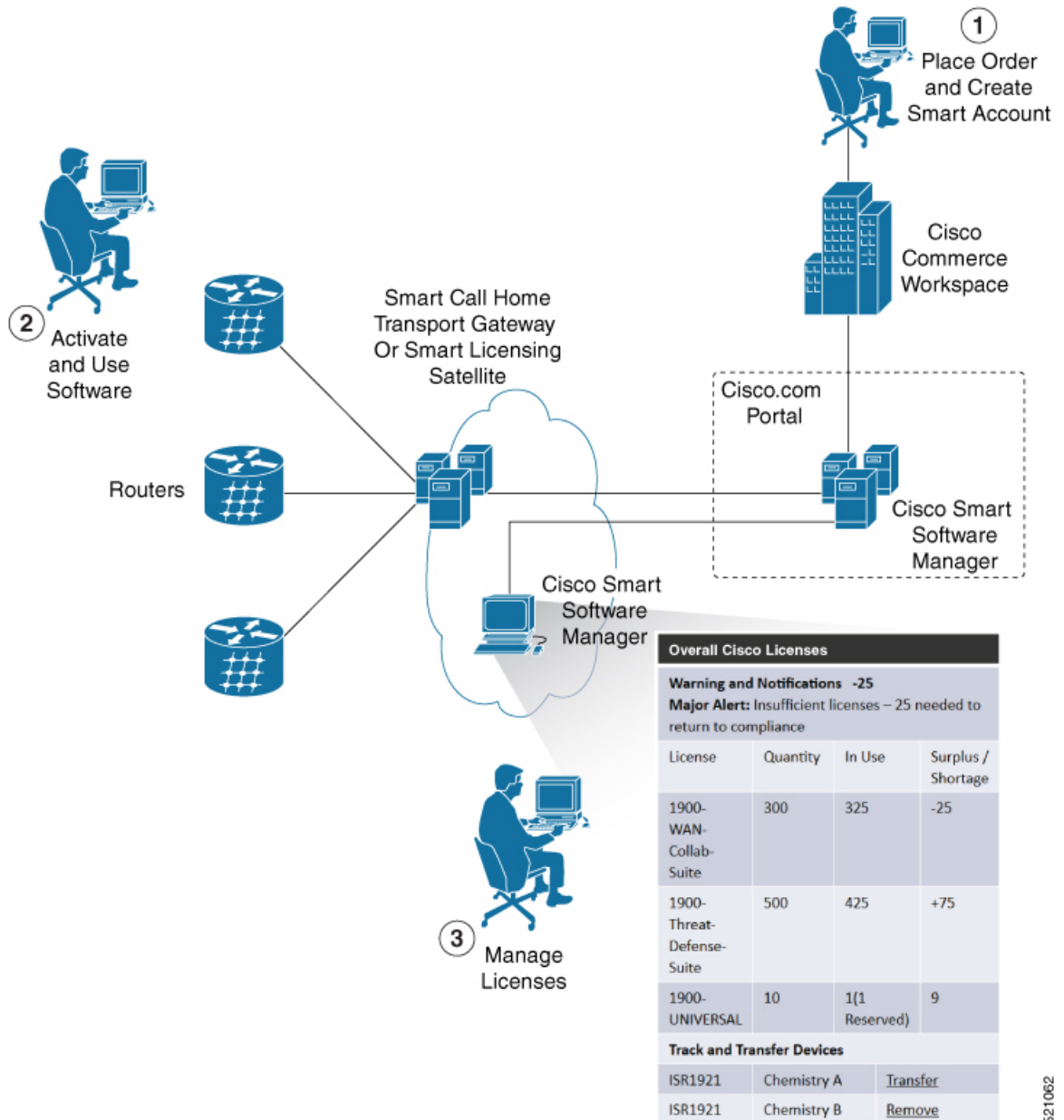
- Copy or download the Authorization code.
- Use the **license smart reservation install file authcode** command to install the Authorization code on the device

How Does Smart Licensing Work?

Table 28: Feature History Table

Feature Name	Release Information	Feature Description
Smart Transport Support	Release 7.4.1	<p>You can now use Smart transport to communicate with CSSM. Smart transport is a transport method where a Smart Licensing (JSON) message is contained within an HTTPs message, and exchanged between a product instance and CSSM, to communicate. The following Smart transport configuration options are available:</p> <ul style="list-style-type: none"> • Smart transport: In this method, a product instance uses a specific Smart transport licensing server URL. This must be configured exactly as shown in the workflow section. • Smart transport through an HTTPs proxy: In this method, a product instance uses a proxy server to communicate with the licensing server, and eventually, CSSM.

Figure 5: Smart Licensing - Workflow



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1. Place Order and Create Smart Account—You must have a Smart Account to set up Smart Licensing.
 - a. Go to <https://software.cisco.com/>.
 - b. Under the **Administration** section, click **Get a Smart Account or Request Access to an Existing Smart Account**.
 - c. Verify or enter your Cisco.com profile details to complete creating a Smart Account.
2. Activate and Use Software—Register your product. For more information, see the *Registering your Router* section. You can use either of the following options to communicate with the CSSM:

- Smart Transport—The Smart Transport method is a transport method where a Smart Licensing (JSON) message is contained within a HTTPs message, and exchanged between a product instance and CSSM to communicate. The following Smart transport configuration options are available.
 - Smart Transport: In this method, a product instance uses a specific Smart transport licensing server URL. This must be configured exactly as shown in the workflow section.
 - Smart transport through an HTTPs proxy: In this method, a product instance uses a proxy server to communicate with the licensing server, and eventually, CSSM.
 - Smart Call Home—The Smart Call Home feature is automatically configured. Smart Call Home is used by Smart Licensing as a medium for communication with the CSSM. You can use this feature to page a network support engineer, email a Network Operations Center, or 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. For more information on Smart Call Home feature, see the [Smart Call Home Deployment Guide](#).
 - Smart Licensing CSSM On-Prem—The Smart licensing on-premise option provides an on-premises collector that can be used to consolidate and manage Smart license usage, as well as facilitate communications back to the CSSM at Cisco.com.
3. Manage Licenses—You can manage and view reports about your overall license usage in the Smart Software Manager portal.

What is Cisco Smart Software Manager?

Cisco Smart Software Manager enables you to manage all of your Cisco Smart software licenses from one centralized website. With Cisco Smart Software Manager, you organize and view your licenses in groups called virtual accounts (collections of licenses and product instances). The Cisco Smart Software Manager allows you to:

- Create, manage, or view virtual accounts
- Create and manage Product Instance Registration Tokens
- Transfer licenses between virtual accounts or view licenses
- Transfer, remove, or view product instances
- Run reports against your virtual accounts
- Modify your email notification settings
- View overall account information

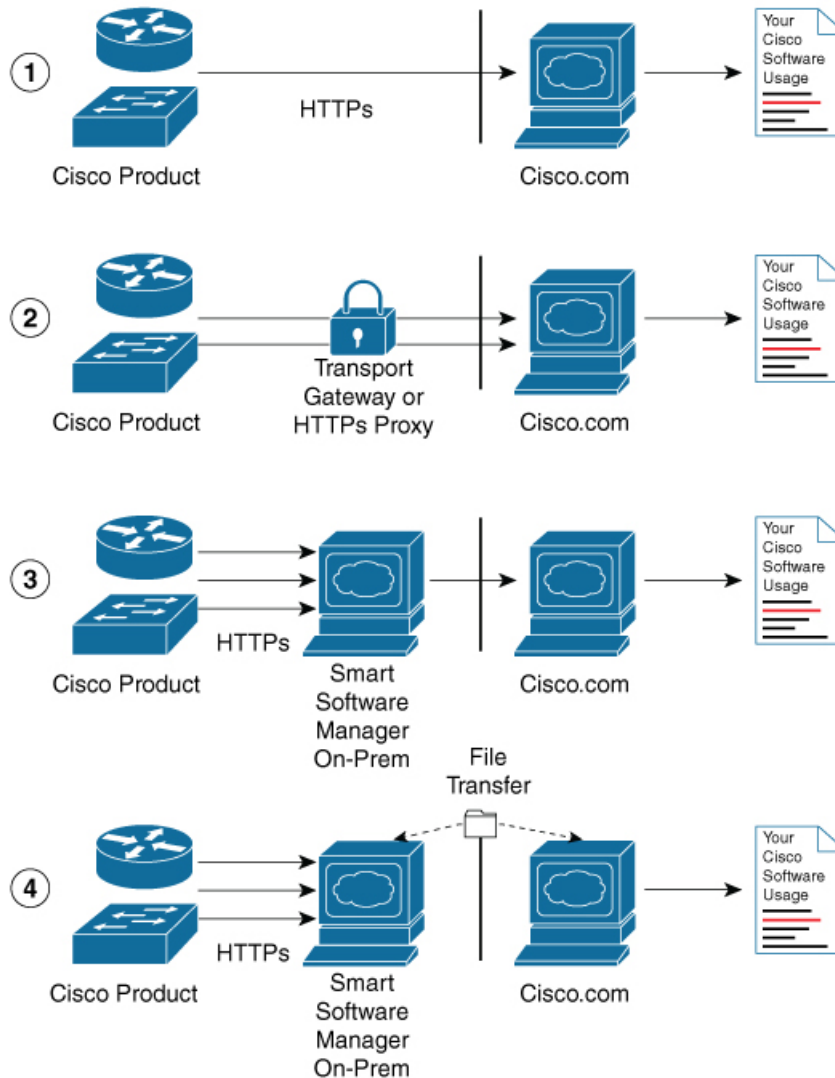
To access the Cisco Smart Software Manager:

- Go to <https://software.cisco.com>.
- Under the **License** section, click **Smart Software Licensing**.

Smart Licensing Deployment Options

The following illustration shows the various options available for deploying Smart Licensing:

Figure 6: Smart Licensing Deployment Options



1. Direct cloud access—In this method, Cisco products send usage information directly over the internet to CSSM on <http://www.cisco.com>; no additional components are needed for deployment.
2. Direct cloud access through an HTTPs proxy—In direct cloud access through an HTTPs proxy deployment method, Cisco products send usage information over the internet through a proxy server—either a Smart Call Home Transport Gateway or off-the-shelf Proxy (such as Apache) to CSSM on <http://www.cisco.com>.
3. Mediated access through an on-premises collector-connected—In mediated access through an on-premises collector-connected deployment method, Cisco products send usage information to a locally connected collector, which acts as a local license authority. Periodically, the information is exchanged to keep the databases in synchronization.

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4. Mediated access through an on-premises collector-disconnected—In the mediated access through an on-premises collector-disconnected deployment method, Cisco products send usage information to a local disconnected collector, which acts as a local license authority. Exchange of human-readable information is performed occasionally (once a month) to keep the databases in synchronization.

Options 1 and 2 provide easy deployment options, whereas options 3 and 4 provide secure environment deployment options.



Note Smart Software On-Premise provides support for options 3 and 4.

The communication between Cisco devices and CSSM is facilitated by the Smart Call Home software.

YANG Data Models for Smart Licensing

Table 29: Feature History Table

Feature Name	Release Information	Description
YANG Data Models for Smart Licensing	Release 7.4.1	<p>With this feature, you can use data models for all the smart licensing operations such as registering your device with a token, renewing token ID, deregistering device to remove the software entitlements and so on using NETCONF remote procedure calls (RPCs).</p> <p>The following data models are introduced:</p> <p>Cisco-IOS-XR-smart-license-cfg.yang cisco-smart-license.yang Cisco-IOS-XR-smartlicense-platform-op.yang Cisco-IOS-XR-infra-smartlicense-op.yang Cisco-IOS-XR-smart-license-act.yang</p> <p>You can access these data models from the Github repository.</p>

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

Data	Data Model	CLI Commands
<p>Configuration data: a set of writable data that is required to configure smart licensing on the router.</p>	<p>Native data model: Cisco-IOS-XR-smart-license-cfg.yang</p>	<ul style="list-style-type: none"> • license smart reservation • [no] license smart reservation • license smart flexible-consumption enable • [no] license smart flexible-consumption enable
<p>Operational state data: a set of data that the system obtains at run time.</p>	<p>Common data model: cisco-smart-license.yang</p> <p>Native data model: Cisco-IOS-XR-smart-license-platform-oper.yang Cisco-IOS-XR-infra-smartlicense-oper.yang</p>	<ul style="list-style-type: none"> • show license platform summary • show license platform detail • show license [all summary usage udi]
<p>Actions: a set of NETCONF actions that support robust networkwide configuration transactions.</p>	<p>Native data model: Cisco-IOS-XR-smart-license-act.yang</p>	<ul style="list-style-type: none"> • license smart register id token • license smart deregister • license smart renew id • license smart renew auth • license smart reservation request local • license smart reservation cancel local • license smart reservation install file <file path> • license smart reservation return local • license smart reservation return authorization file <file path> • license smart transport smart • license smart url <url> • license smart software-upgrade enable • license smart proxy hostname <hostname/ip> • license smart proxy port <port>

You can access the data models from the [Github](#) repository. To learn more about the data models and put them to use, see the *Programmability Configuration Guide for Cisco NCS 5500 Series Routers*.

Configuring Smart Licensing

Prerequisites for Configuring Smart Licensing

Ensure that you have completed the following activities on Cisco Smart Software Manager:

- Set up a Cisco Smart Account. For more information, see the *How Smart Licensing Works* section in this document.
- Set up Virtual Account or accounts. For more information, see the *Virtual Accounts* section in the [Smart Software Manager Help](#).
- Create user roles in the **Users** tab in the **Manage Smart Account** page. Provide the appropriate user access rights.
- Accept the Smart Software Licensing Agreement on Cisco Smart Software Manager to register your router.
- Have a layer 3 connection set up on your router.
- Configure a valid DNS and proper time on the router to connect CSSM or CSSM On-Prem.

Setting up the Router for Smart Licensing

Table 30: Three-step Roadmap to Set up the Router for Smart Licensing

Activity	Communication Connection Options		
Step 1—Configure Communications	See the <i>Configuring a Direct Cloud Connection</i> section.	See the <i>Configuring a Connection through a HTTP Proxy</i> section.	See the <i>Connecting to CSSM On-Premise</i> section.
Step 2—Register and Activate	See the <i>Registering and Activating your Router</i> section.		
Step 3—Verify the Configuration	See the <i>Verifying your Smart Licensing Configuration</i> section.		

Configuring a Communications Connection Between the Router and Cisco Smart Software Manager

Configuring a Direct Cloud Connection

In this deployment option, the **configure call-home profile** is configured by default. Use the **show call-home profile all** command to check the profile status.

Call Home service provides email-based and web-based notification of critical system events to Cisco Smart Software Manager.

To configure and enable Call Home service:

SUMMARY STEPS

1. **configure terminal**
2. **call-home**
3. **service active**
4. **contact-email-addr** *email-address*
5. **profile CiscoTAC-1**
6. **destination transport-method http**
7. **destination address http** *url*
8. **active**
9. **no destination transport-method email**
10. **commit**
11. **exit**
12. **exit**

DETAILED STEPS

	Command or Action	Purpose
Step 1	configure terminal Example: Router# configure terminal	Enters global configuration mode.
Step 2	call-home Example: Router(config)# call-home	Enters Call Home configuration mode.
Step 3	service active Example: Router(config-call-home)# service active	Activates Call Home service.
Step 4	contact-email-addr <i>email-address</i> Example: Router(config-call-home)# contact-email-addr username@example.com	Assigns the provided email address. You can enter up to 200 characters in email address format. Note Spaces are not allowed in the email address.
Step 5	profile CiscoTAC-1 Example: Router(config-call-home)# profile CiscoTAC-1	Enables the CiscoTAC-1 profile to be used with the Call Home service. By default, the CiscoTAC-1 profile is disabled.
Step 6	destination transport-method http Example: Router(config-call-home-profile)# destination transport-method http	Enables the Call Home service through an HTTP connection.

	Command or Action	Purpose
Step 7	destination address http <i>url</i> Example: <pre>Router(config-call-home-profile)# destination address http https://tools.cisco.com/its/service/odce/services/DDCEService</pre>	Connects the router to the Cisco Smart Software Manager.
Step 8	active Example: <pre>Router(config-call-home-profile)# active</pre>	Enables the destination profile.
Step 9	no destination transport-method email Example: <pre>Router(config-call-home-profile)# no destination transport-method email</pre>	Disables the email option for the Call Home service.
Step 10	commit Example: <pre>Router(config-call-home-profile)# commit</pre>	Commits the configuration.
Step 11	exit Example: <pre>Router(config-call-home-profile)# exit</pre>	Exits the Call Home destination profile configuration mode and returns to the Call Home configuration mode.
Step 12	exit Example: <pre>Router(config-call-home)# exit Router(config)#</pre>	Exits the Call Home configuration mode and returns to the global configuration mode.

Configuring a Connection Through an HTTP Proxy

The Call Home service can be configured through an HTTPs proxy server.

SUMMARY STEPS

1. **configure terminal**
2. **call-home**
3. **service active**
4. **contact-email-address *email-address***
5. **http-proxy *proxy-address* port *port-number***
6. **profile CiscoTAC-1**
7. **no destination transport-method email**
8. **exit**
9. **profile *profile-name***
10. **reporting smart-licensing-data**
11. **destination transport-method http**
12. **destination address http *url***

13. active
14. exit
15. exit
16. commit

DETAILED STEPS

	Command or Action	Purpose
Step 1	configure terminal Example: Router# configure terminal	Enters global configuration mode.
Step 2	call-home Example: Router(config)# call-home	Enters Call Home configuration mode.
Step 3	service active Example: Router(config-call-home)# service active	Enables the Call Home feature.
Step 4	contact-email-address <i>email-address</i> Example: Router(config-call-home)# contact-email-addr sch-smart-licensing@cisco.com	Configures the default email address.
Step 5	http-proxy <i>proxy-address</i> port <i>port-number</i> Example: Router(config-call-home)# http-proxy 198.51.100.10 port 3128	Provides the proxy server information to the Call Home service.
Step 6	profile CiscoTAC-1 Example: Router(config-call-home)# profile CiscoTAC-1	Enables the CiscoTAC-1 profile to be used with the Call Home service. By default, the CiscoTAC-1 profile is disabled.
Step 7	no destination transport-method email Example: Router(config-call-home-profile)# no destination transport-method email	Disables the email option for the Call Home service.
Step 8	exit Example: Router(config-call-home-profile)# exit Router(config-call-home)#	Exits the Call Home destination profile configuration mode and returns to the Call Home configuration mode.
Step 9	profile <i>profile-name</i> Example: Router(config-call-home)# profile test1	Enters the Call Home destination profile configuration mode for the specified destination profile name. If the specified destination profile does not exist, it is created.

	Command or Action	Purpose
Step 10	reporting smart-licensing-data Example: <pre>Router(config-call-home-profile)# reporting smart-licensing-data</pre>	Enables data sharing with the Call Home service through the configured transport method, in this case, HTTP.
Step 11	destination transport-method http Example: <pre>Router(config-call-home-profile)# destination transport-method http</pre>	Enables the HTTP message transport method.
Step 12	destination address http url Example: <pre>Router(config-call-home-profile)# destination address http https://tools.cisco.com/its/service/odce/services/DDCEService</pre>	Connects the router to the Cisco Smart Software Manager.
Step 13	active Example: <pre>Router(config-call-home-profile)# active</pre>	Enables the destination profile.
Step 14	exit Example: <pre>Router(config-call-home-profile)# exit</pre>	Exits the Call Home destination profile configuration mode and returns to the Call Home configuration mode.
Step 15	exit Example: <pre>Router(config-call-home)# exit Router(config)#</pre>	Exits the Call Home configuration mode and returns to the global configuration mode.
Step 16	commit Example: <pre>Router(config)# commit</pre>	Commits the configuration.

Configuring Smart Transport Through an HTTPs Proxy

To use a proxy server to communicate with CSSM when using the Smart transport mode, complete the following steps:



Note Authenticated HTTPs proxy configurations are not supported.

SUMMARY STEPS

1. **configure terminal**
2. **license smart transport smart**

3. **license smart url***transport-url*
4. **license smart proxy** *hostname***port***port-number*
5. **commit**

DETAILED STEPS

	Command or Action	Purpose
Step 1	configure terminal Example: Router# <code>configure terminal</code>	Enters global configuration mode.
Step 2	license smart transport smart Example: Router(config)# <code>license smart transport smart</code>	Enables Smart transport mode. Automatically configures the Smart URL. (https://smartreceiver.cisco.com/licservice/license).
Step 3	license smart url <i>transport-url</i> Example: Router(config)# <code>license smart url https://your-transport-url.com</code>	Configures the url of smart transport for transporting messages. <i>transport-url</i> : The Smart Transport url
Step 4	license smart proxy <i>hostname</i> port <i>port-number</i> Example: Router(config)# <code>license smart proxy 198.51.100.10 port 3128</code>	Configures a proxy for the Smart transport mode. When a proxy is configured, licensing messages are sent to the proxy along with the final destination URL (CSSM). The proxy sends the message on to CSSM. Provide the address and port information: <ul style="list-style-type: none"> • hostname: Enter the IP Address or hostname of the proxy server. • port: Specifies the proxy port. Enter the proxy port number.
Step 5	commit Example: Router(config)# <code>commit</code>	Commits the configuration.

Connecting to CSSM On-Premise

This section describes how to configure the Call Home service for on-premise smart software through connected or disconnected mode.

SUMMARY STEPS

1. **configure terminal**
2. **call-home**
3. **profile** *profile-name*
4. **reporting smart-licensing-data**
5. **destination transport-method** `http`

6. **destination address http url**
7. **no destination address http url**
8. **destination preferred-msg-format {long-text | short-text | xml}**
9. **active**
10. **exit**
11. **exit**
12. **http client source-interface ip-version interface-type interface-number**
13. **crypto ca trustpool policy crl optional**
14. **commit**
15. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	configure terminal Example: Router# configure terminal	Enters global configuration mode.
Step 2	call-home Example: Router(config)# call-home	Enters Call Home configuration mode.
Step 3	profile profile-name Example: Router(config-call-home)# profile test1	Enters the 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	reporting smart-licensing-data Example: Router(config-call-home-profile)# reporting smart-licensing-data	Enables data sharing with the Call Home service through the configured transport method, in this case, HTTP.
Step 5	destination transport-method http Example: Router(config-call-home-profile)# destination transport-method http	Enables the HTTP message transport method.
Step 6	destination address http url Example: Router(config-call-home-profile)# destination address http http://209.165.201.15/Transportgateway/services/DeviceRequestHandler Or Router(config-call-home-profile)# destination address http https://209.165.201.15/Transportgateway/services/DeviceRequestHandler	Configures the destination URL (CSSM) to which Call Home messages are sent. Ensure the IP address or the fully qualified domain name (FQDN) in the destination URL matches the IP address or the FQDN as configured for the Host Name on the CSSM On-Prem.

	Command or Action	Purpose
Step 7	no destination address http url Example: <pre>Router(config-call-home-profile)# no destination address http https://tools.cisco.com/its/service/oddce/services/DDCEService</pre>	Removes the default destination address.
Step 8	destination preferred-msg-format {long-text short-text xml} Example: <pre>Router(config-call-home-profile)# destination preferred-msg-format xml</pre>	(Optional) Configures a preferred message format. The default message format is XML.
Step 9	active Example: <pre>Router(config-call-home-profile)# active</pre>	Enables the destination profile.
Step 10	exit Example: <pre>Router(config-call-home-profile)# exit</pre>	Exits the Call Home destination profile configuration mode and returns to the Call Home configuration mode.
Step 11	exit Example: <pre>Router(config-call-home)# exit Router(config)#</pre>	Exits the Call Home configuration mode and returns to the global configuration mode.
Step 12	http client source-interface ip-version interface-type interface-number Example: <pre>Router(config)# http client source-interface ipv4 Vlan100</pre>	Configures a source interface for the HTTP client. Note This command is mandatory for a VRF interface.
Step 13	crypto ca trustpool policy crl optional Example: <pre>Router(config)# crypto ca trustpool policy crl optional</pre>	(Optional) Bypasses the Certificate Revocation Lists (CRLs) check and establishes the connection. By default, the CRLs check is mandatory while establishing a TLS connection. We recommend this step when the smart licensing-enabled router is within a network and can rely on the License server to check the certificate status without retrieving and caching each CRL for every peer.
Step 14	commit Example: <pre>Router(config)# commit</pre>	Commits the configuration.
Step 15	end Example: <pre>Router(config)# end</pre>	Returns to the global configuration mode.

Installing CSSM On-Premise

For information on installation instructions, see the [Smart Software Manager On-Prem Installation Guide](#).

Registering and Activating Your Router

Product registration securely associates a device with the Smart Account and the Virtual Account of your choice. It also establishes trust between the end product and the CSSM. Tokens are used to register a product with the appropriate Virtual Account on CSSM Cloud (on Cisco.com) or CSSM On-Premise.



Note When the router is in an unregistered state, the licenses are in EVAL (evaluation) mode. Evaluation period will last for 90 days.

A Registration Token:

- Can be either used once or reused multiple times. You can set a limit to the number of times a token can be reused when you create the token.
- Can be created and revoked at any time.
- Expires after a period of time (default is 30 days; minimum is one day; maximum is 365 days)

A Registration Token is not:

- Product specific: The same Registration Token can be used on different product types.
- A license, key, or PAK.
- Stored on the Cisco device and they are not persistent.
- Required after the product is registered. Token expiration has no effect on previously registered products; it simply means that that token can no longer be used to register a new product.

Generating a New Token from CSSM

-
- Step 1** If you choose the direct cloud access deployment option, log in to CSSM from <https://software.cisco.com/#>.
If you chose the mediated access deployment option, log in to CSSM On-Prem from <https://<on-prem-ip-address>:8443>.
- Step 2** Select the **Inventory** tab.
- Step 3** From the Virtual Account drop-down list, choose the virtual account to which you want to register your product.
- Step 4** Select the **General** tab.
- Step 5** Click **New Token**.

The screenshot displays the Cisco Software Central interface for Smart Software Licensing. The page title is 'Smart Software Licensing' and the virtual account is 'IOSXR'. The 'Product Instance Registration Tokens' section is active, showing a table with columns for Token, Expiration Date, Uses, Export-Controlled, Description, Created By, and Actions. A 'New Token...' button is highlighted with a red box. The footer contains links for Contacts, Feedback, Help, Site Map, Terms & Conditions, Privacy Statement, Cookie Policy, and Trademarks.

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The **Create Registration Token** window is displayed.

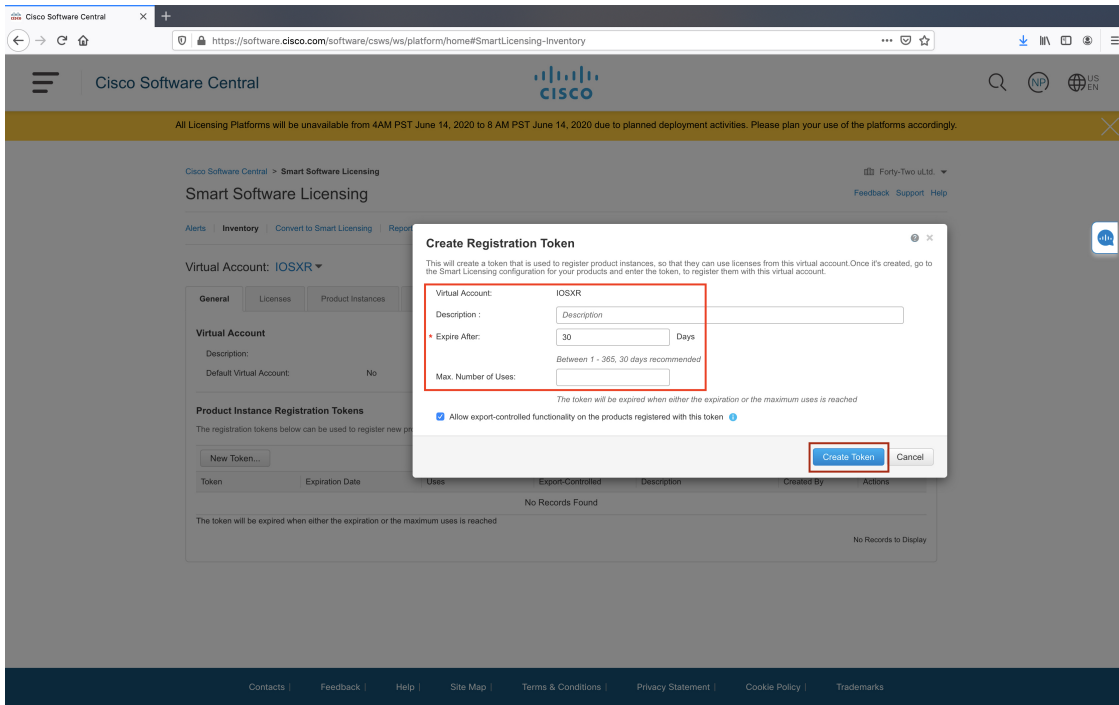
Step 6

In the **Description** field, enter the token description.

In the **Expire After** field, enter the number of days the token must be active. The default value is 30 days.

In the **Max. Number of Uses** field, enter the maximum number of uses allowed after which the token expires.

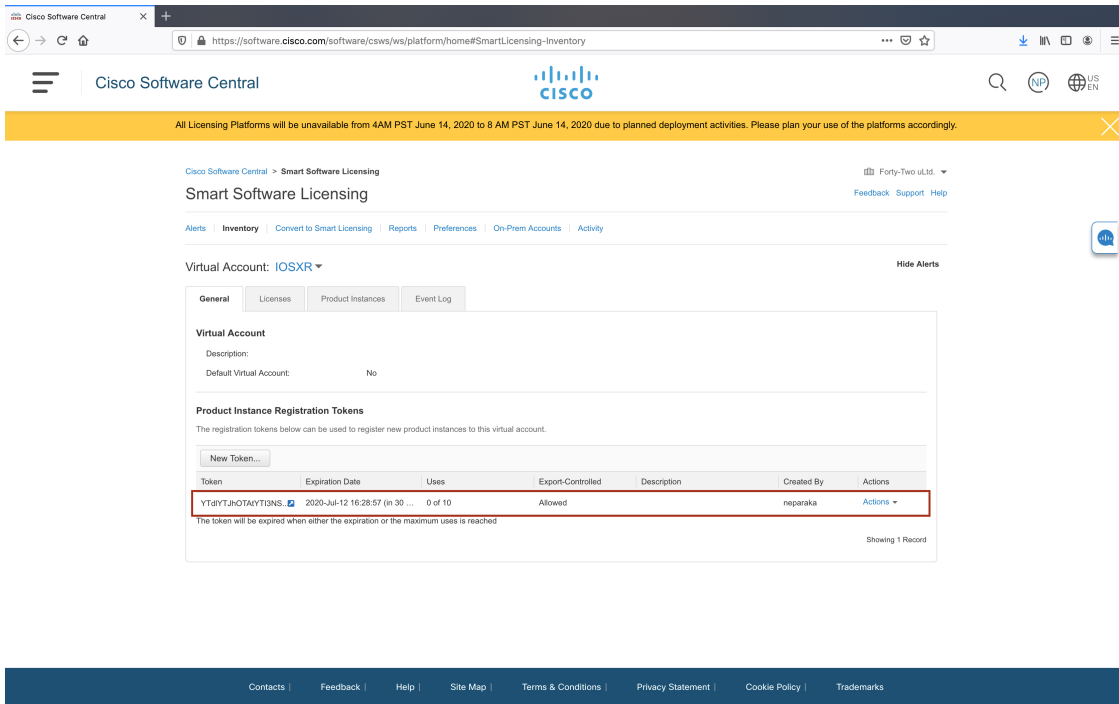
Select the **Allow export-controlled functionality on the products registered with this token** checkbox to ensure Cisco compliance with US and country-specific export policies and guidelines. For more information, see <https://www.cisco.com/c/en/us/about/legal/global-export-trade.html>.



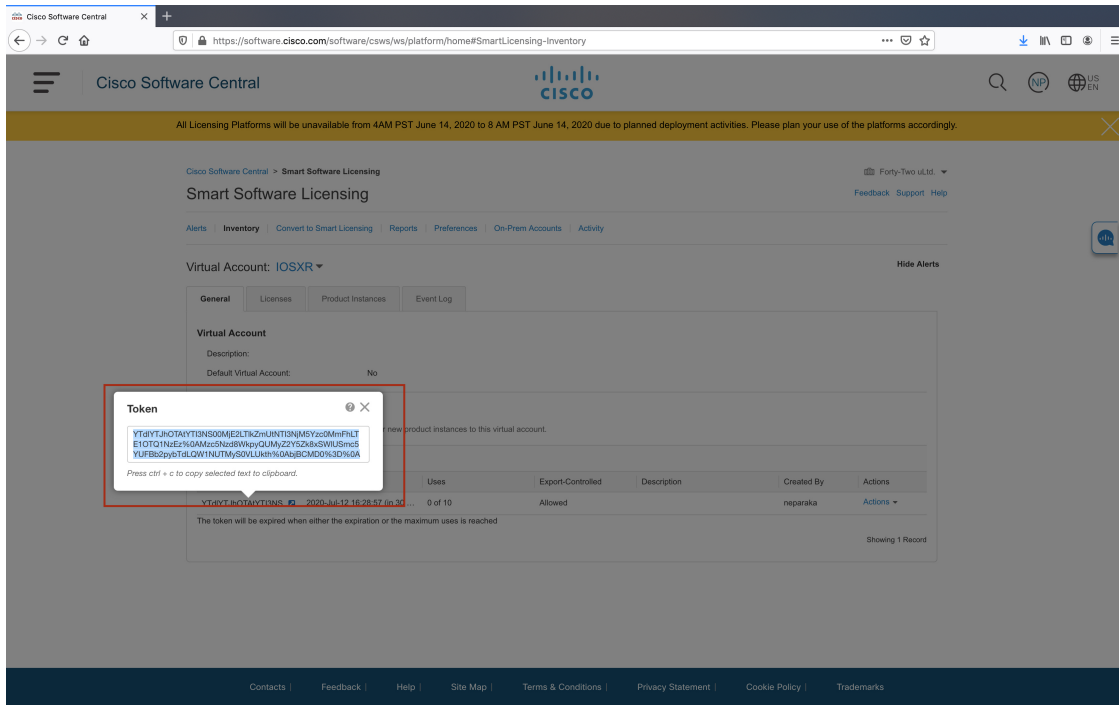
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Click **Create Token**.

Step 7 After the token is created, select and copy the token to a text file.



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You need this token to register your router.

What to do next

See the *Registering Your Device With the Token* section.

Registering Your Device With the Token

SUMMARY STEPS

1. license smart register idtoken *token-ID*

DETAILED STEPS

	Command or Action	Purpose
Step 1	<p>license smart register idtoken <i>token-ID</i></p> <p>Example:</p> <pre>license smart register idtoken \$Tl4UytrNXBzbEs1ck8veUtWag5abnZJOfdDa1FwbvRa%0Ab1RMbz0%3D%0A</pre>	Registers Smart Licensing on the router using the registration token created in the CSSM. On successful registration, the product instance is created in the CSSM virtual account and its license usage is displayed on the CSSM.

Example

Register Device Using YANG Data Model

As an alternative to the CLI command, the `Cisco-IOS-XR-smart-license-act` YANG data model can also be used to register your device with CSSM On-prem server. The following example shows the NETCONF RPC request:

```
<rpc xmlns="urn:ietf:params:xml:ns:netconf:base:1.0" message-id="101">
  <register-id-token xmlns="http://cisco.com/ns/yang/Cisco-IOS-XR-smart-license-act">
    <id-token>$Tl4UytrNXBzbEs1ck8veUtWaG5abnZJOFdDa1FwbVRa%0Ab1Rmbz0%3D%0A</id-token>
  </register-id-token>
</rpc>
```

Renewing Your Smart Licensing Registration

Your registration is automatically renewed every six months. To find the status of the license, use the **license smart renew auth** command.

As long as the license is in an 'Authorized' or 'Out-of-compliance' (OOC) state, the authorization period is renewed. Grace period starts when an authorization period expires. During the grace period or when the grace period is in the 'Expired' state, the system continues to try to renew the authorization period. If a retry is successful, a new authorization period starts.



Note If the smart license renewal fails, then the product instance goes to an unidentified state and starts consuming the evaluation period.

Before you begin

Ensure that the following conditions are met to renew your smart license:

- Smart licensing is enabled.
- The router is registered.

SUMMARY STEPS

1. **license smart renew {auth | id}**

DETAILED STEPS

	Command or Action	Purpose
Step 1	license smart renew {auth id} Example: Router# license smart renew auth	Renews your token ID or authorization with Cisco smart licensing.

Example

Renew Token ID Using YANG Data Model

You can renew your token ID or smart licensing registration using `Cisco-IOS-XR-smart-license-act` YANG data model. The following example shows the NETCONF RPC request:

```
<rpc xmlns="urn:ietf:params:xml:ns:netconf:base:1.0" message-id="101">
  <renew-id xmlns="http://cisco.com/ns/yang/Cisco-IOS-XR-smart-license-act"/>
</rpc>
```

To renew the authorization, use the following NETCONF RPC request:

```
<rpc xmlns="urn:ietf:params:xml:ns:netconf:base:1.0" message-id="101">
  <renew-auth xmlns="http://cisco.com/ns/yang/Cisco-IOS-XR-smart-license-act"/>
</rpc>
```

Deregistering Your Router from CSSM

When a router is taken off the inventory, shipped elsewhere for redeployment, or returned to Cisco for replacement, you can deregister that router.

Before you begin

Ensure that a Layer 3 connection to CSSM is available to successfully deregister the device.

SUMMARY STEPS

1. license smart deregister

DETAILED STEPS

	Command or Action	Purpose
Step 1	license smart deregister Example: Router# license smart deregister	Cancels the registration of the router and sends the router into evaluation mode. All smart licensing entitlements and certificates on the corresponding platform are removed. The product instance of the router stored on CSSM is also removed.

Example

Deregister Device Using YANG Data Model

You can deregister your device with CSSM On-prem server using `Cisco-IOS-XR-smart-license-act` YANG data model. The following example shows the NETCONF RPC request:

```
<rpc xmlns="urn:ietf:params:xml:ns:netconf:base:1.0" message-id="101">
  <de-register xmlns="http://cisco.com/ns/yang/Cisco-IOS-XR-smart-license-act"/>
</rpc>
```

Verifying the Smart Licensing Configuration

Use the following **show** commands to verify the default Smart Licensing configuration. If any issue is detected, take corrective action before making further configurations.

SUMMARY STEPS

1. `show license status`
2. `show license all`
3. `show license status`
4. `show license udi`
5. `show license summary`
6. `show license platform summary`
7. `show license platform detail`
8. `show call-home smart-licensing statistics`

DETAILED STEPS

	Command or Action	Purpose
Step 1	<p><code>show license status</code></p> <p>Example:</p> <pre>Router# show license status</pre>	<p>Displays the compliance status of Smart Licensing. Following are the possible status:</p> <ul style="list-style-type: none"> • Waiting—Indicates that the initial state after your device has made a license entitlement request. The device establishes communication with Cisco and successfully registers itself with the Cisco license manager. • Authorized—Indicates that your device is able to communicate with the Cisco license manager, and is authorized to initiate requests for license entitlements. • Out-Of-Compliance—Indicates that one or more of your licenses are out-of-compliance. Buy more licenses, or renew the existing licenses. • Eval Period—Indicates that Smart Licensing is consuming the evaluation period. Register the device with the Cisco Licensing manager, else your license expires. <p>Note Repetitive 'Smart Licensing evaluation expired' warning messages are displayed on the console every hour, but there is no functionality impact on the device. To stop these repetitive messages, register the device again with new a registration token.</p> <ul style="list-style-type: none"> • Disabled—Indicates that Smart Licensing is disabled. • Invalid—Indicates that Cisco does not recognize the entitlement tag as the tag is not in the database.
Step 2	<p><code>show license all</code></p> <p>Example:</p> <pre>Router# show license all</pre>	<p>Displays all entitlements in use. The output also displays the associated licensing certificates, compliance status, Unique Device Identifier (UDI), and other details.</p>

	Command or Action	Purpose
Step 3	show license status Example: Router# show license status	Displays the status of all entitlements in use.
Step 4	show license udi Example: Router# show license udi	Displays the Unique Device Identifier (UDI) information.
Step 5	show license summary Example: Router# show license summary	Displays a summary of all entitlements in use.
Step 6	show license platform summary Example: Router# show license platform summary	Displays the registration status and provides detailed information about the essential, advantage without essentials, advantage with essentials, and tracking license consumption in generic or vortex license model.
Step 7	show license platform detail Example: Router# show license platform detail	Displays detailed information about: <ul style="list-style-type: none"> • Licenses that can be consumed on a platform in both, generic and vortex models • The active model, whether generic or vortex model • The current count and the next consumption count of a license
Step 8	show call-home smart-licensing statistics Example: Router# show call-home smart-licensing statistics	Displays statistics of the communication between the Smart Licensing manager and the Cisco back-end using Smart Call Home. Note If the communication fails or drops, check your call home configuration for any errors.

Smart Licensing Configuration Examples

Example: Viewing the Call Home Profile

To display the **http Call Home profile** or the **On-Prem Call Home profile**, use the **show call-home profile all** command.

```
Router# show call-home profile all
Tue Aug 18 23:52:16.590 UTC
```

```
Profile Name: CiscoTAC-1
Profile status: ACTIVE
Profile mode: Full Reporting
Reporting Data: Smart Call Home, Smart Licensing
Preferred Message Format: xml
Message Size Limit: 3145728 Bytes
```

```

Transport Method: http
HTTP address(es): https://tools.cisco.com/its/service/oddce/services/DDCEService
Other address(es): default

```

Periodic configuration info message is scheduled every 17 day of the month at 13:15

Periodic inventory info message is scheduled every 17 day of the month at 13:0

```

Alert-group          Severity
-----
inventory            normal

Syslog-Pattern      Severity
-----
.*                  critical

```

```
Router# show call-home profile all
```

```
Wed Aug 19 01:55:14.974 UTC
```

```

Profile Name: CiscoTAC-1
Profile status: ACTIVE
Profile mode: Full Reporting
Reporting Data: Smart Call Home, Smart Licensing
Preferred Message Format: xml
Message Size Limit: 3145728 Bytes
Transport Method: http
HTTP address(es): http://10.30.110.38/Transportgateway/services/DeviceRequestHandler
Other address(es): default

```

Periodic configuration info message is scheduled every 17 day of the month at 13:15

Periodic inventory info message is scheduled every 17 day of the month at 13:0

```

Alert-group          Severity
-----
inventory            normal

Syslog-Pattern      Severity
-----
.*                  critical

```

Example: Viewing License Information Before Registration

To display the license entitlements, use the **show license all** command:

```

Router# show license all
Smart Licensing Status
=====

Smart Licensing is ENABLED

Registration:
Status: UNREGISTERED
Export-Controlled Functionality: NOT ALLOWED

License Authorization:
Status: EVAL MODE
Evaluation Period Remaining: 83 days, 23 hours, 36 minutes, 0 seconds

Export Authorization Key:
Features Authorized:
<none>

```

```

Utility:
  Status: DISABLED

Data Privacy:
  Sending Hostname: yes
  Callhome hostname privacy: DISABLED
  Smart Licensing hostname privacy: DISABLED
  Version privacy: DISABLED

Transport:
  Type: Callhome

License Usage
=====

(ESS-100G-RTU-1):
  Description:
  Count: 1
  Version: 1.0
  Status: EVAL MODE
  Export status: NOT RESTRICTED

(NCS-5501-TRK):
  Description:
  Count: 1
  Version: 1.0
  Status: EVAL MODE
  Export status: NOT RESTRICTED

Product Information
=====
UDI: PID:NCS-5501,SN:FOC2137R1SL

Agent Version
=====
Smart Agent for Licensing: 4.9.6_rel/41

Reservation Info
=====
License reservation: DISABLED

```

To display the license usage information, use the **show license usage** command:

```

Router# show license usage

License Authorization:
  Status: EVAL MODE
  Evaluation Period Remaining: 83 days, 23 hours, 34 minutes, 34 seconds

(ESS-100G-RTU-1):
  Description:
  Count: 1
  Version: 1.0
  Status: EVAL MODE
  Export status: NOT RESTRICTED

(NCS-5501-TRK):
  Description:
  Count: 1
  Version: 1.0
  Status: EVAL MODE
  Export status: NOT RESTRICTED

```

To display all the license summaries, use the **show license summary** command:

```

Router# show license summary
Smart Licensing is ENABLED

Registration:
  Status: UNREGISTERED
  Export-Controlled Functionality: NOT ALLOWED

License Authorization:
  Status: EVAL MODE
  Evaluation Period Remaining: 83 days, 23 hours, 33 minutes, 52 seconds

License Usage:
  License                               Entitlement tag                Count Status
  -----
                               (ESS-100G-RTU-1)                1 EVAL MODE
                               (NCS-5501-TRK)                   1 EVAL MODE

```

To display the license status information, use the **show license status** command:

```

Router# show license status

Smart Licensing is ENABLED

Utility:
  Status: DISABLED

Data Privacy:
  Sending Hostname: yes
  Callhome hostname privacy: DISABLED
  Smart Licensing hostname privacy: DISABLED
  Version privacy: DISABLED

Transport:
  Type: Callhome

Registration:
  Status: UNREGISTERED
  Export-Controlled Functionality: NOT ALLOWED

License Authorization:
  Status: EVAL MODE
  Evaluation Period Remaining: 83 days, 23 hours, 32 minutes, 57 seconds

Export Authorization Key:
  Features Authorized

```

Example: Registering the Router

To register a device, use the **license smart register idtoken** command:

```

Router# license smart register idtoken
Tl4UytrNXBzbEs1ck8veUtWaG5abnZJOFdDalFwbVRa%0Ab1RMbz0%3D%0A

```

Example: Viewing License Information After Registration

To display the license entitlements, use the **show license all** command

```

Router# show license all
Smart Licensing Status
=====

Smart Licensing is ENABLED

```

```

Registration:
  Status: REGISTERED
  Smart Account: Forty-Two uLtd.
  Virtual Account: IOSXR
  Export-Controlled Functionality: ALLOWED
  Initial Registration: SUCCEEDED on Aug 18 2020 23:51:46 UTC
  Last Renewal Attempt: None
  Next Renewal Attempt: Feb 14 2021 23:51:46 UTC
  Registration Expires: Aug 18 2021 23:46:43 UTC

License Authorization:
  Status: OUT OF COMPLIANCE on Aug 18 2020 23:51:57 UTC
  Last Communication Attempt: SUCCEEDED on Aug 18 2020 23:51:57 UTC
  Next Communication Attempt: Aug 19 2020 11:51:57 UTC
  Communication Deadline: Nov 16 2020 23:46:56 UTC

Export Authorization Key:
  Features Authorized:
    <none>

Utility:
  Status: DISABLED

Data Privacy:
  Sending Hostname: yes
  Callhome hostname privacy: DISABLED
  Smart Licensing hostname privacy: DISABLED
  Version privacy: DISABLED

Transport:
  Type: Callhome

License Usage
=====

Core and Aggregation Essentials SW Right-to-Use v1.0 per 100G (ESS-100G-RTU-1):
  Description: Core and Aggregation Essentials SW Right-to-Use v1.0 per 100G
  Count: 1
  Version: 1.0
  Status: OUT OF COMPLIANCE
  Export status: NOT RESTRICTED

5501 Base Hardware Tracking PID (NCS-5501-TRK):
  Description: 5501 Base Hardware Tracking PID
  Count: 1
  Version: 1.0
  Status: OUT OF COMPLIANCE
  Export status: NOT RESTRICTED

Product Information
=====
UDI: PID:NCS-5501,SN:FOC2137R1SL

Agent Version
=====
Smart Agent for Licensing: 4.9.6_rel/41

Reservation Info
=====
License reservation: DISABLED

```

View License Entitlement Using YANG Data Model

You can view the license entitlements using Cisco-IOS-XR-infra-smartlicense-oper YANG data model. Use the following NETCONF RPC request:

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

To display the license usage information, use the **show license usage** command:

```
Router# show license usage
License Authorization:
  Status: OUT OF COMPLIANCE on Aug 18 2020 23:51:57 UTC

Core and Aggregation Essentials SW Right-to-Use v1.0 per 100G (ESS-100G-RTU-1):
  Description: Core and Aggregation Essentials SW Right-to-Use v1.0 per 100G
  Count: 1
  Version: 1.0
  Status: OUT OF COMPLIANCE
  Export status: NOT RESTRICTED

5501 Base Hardware Tracking PID (NCS-5501-TRK):
  Description: 5501 Base Hardware Tracking PID
  Count: 1
  Version: 1.0
  Status: OUT OF COMPLIANCE
  Export status: NOT RESTRICTED
```

To display all the license summaries, use the **show license summary** command:

```
Router# show license summary
Smart Licensing is ENABLED

Registration:
  Status: REGISTERED
  Smart Account: Forty-Two uLtd.
  Virtual Account: IOSXR
  Export-Controlled Functionality: ALLOWED
  Last Renewal Attempt: None
  Next Renewal Attempt: Feb 14 2021 23:51:46 UTC

License Authorization:
  Status: OUT OF COMPLIANCE
  Last Communication Attempt: SUCCEEDED
  Next Communication Attempt: Aug 19 2020 11:51:56 UTC

License Usage:
```

License	Entitlement tag	Count	Status
Core and Aggregation...	(ESS-100G-RTU-1)	1	OUT OF COMPLIANCE
5501 Base Hardware T...	(NCS-5501-TRK)	1	OUT OF COMPLIANCE

To display the license status information, use the **show license status** command:

```
Router# show license status
```

```

Smart Licensing is ENABLED

Utility:
  Status: DISABLED

Data Privacy:
  Sending Hostname: yes
  Callhome hostname privacy: DISABLED
  Smart Licensing hostname privacy: DISABLED
  Version privacy: DISABLED

Transport:
  Type: Callhome

Registration:
  Status: REGISTERED
  Smart Account: Forty-Two uLtd.
  Virtual Account: IOSXR
  Export-Controlled Functionality: ALLOWED
  Initial Registration: SUCCEEDED on Aug 18 2020 23:51:46 UTC
  Last Renewal Attempt: None
  Next Renewal Attempt: Feb 14 2021 23:51:45 UTC
  Registration Expires: Aug 18 2021 23:46:42 UTC

License Authorization:
  Status: OUT OF COMPLIANCE on Aug 18 2020 23:51:57 UTC
  Last Communication Attempt: SUCCEEDED on Aug 18 2020 23:51:57 UTC
  Next Communication Attempt: Aug 19 2020 11:51:56 UTC
  Communication Deadline: Nov 16 2020 23:46:55 UTC

Export Authorization Key:
  Features Authorized:
    <none>

```

Specific License Reservation

Table 31: Feature History Table

Feature Name	Release	Feature Description
Specific License Reservation	Release 7.3.1	Specific License Reservation (SLR) allows customers in highly secure networks to utilize smart licenses without communicating the license information to the Cisco Smart Software manager (CSSM).

SLR is reservation of specific licenses from the smart account as per the usage on the router. Whereas, PLR is for selected customers who don't want tracking of license usage. This license allows unlimited usage without taking into consideration of license usage on the router.

Specific License Reservation (SLR) allows customers in highly secure networks to utilize smart licenses without communicating the license information to the Cisco Smart Software manager (CSSM). Routers that are registered with smart licenses share router information at regular intervals with Cisco Smart Software Manager (CSSM). Routers that are deployed in a highly secure network must not share the router information externally. Cisco offers license reservation as an on-request configuration for these routers.

Specific License Reservation is a solution designed for classified environments that don't allow electronic communication in or out of the environment. In such environments, routers are unable to communicate with the Cisco Smart Software Manager (CSSM) directly or through CSSM OnPrem. These deployments can use SLR that allows using all entitlements on the router without communicating to Cisco.

To enable and use the SLR feature, generate a reservation request code from the router. Use this code in the CSSM portal to reserve an available SLR license and generate an authorization code. When you enter this authorization code in the router CLI, the license reservation becomes effective.

Limitations

- License reservation provides limited or no functionality to certain smart licensing features such as transfer of licenses between products, license usage, asset management and so on.
- To use the Specific License Reservation feature, you must have an approval and authorization from Cisco. For assistance, go to www.cisco.com/go/scm or contact your account representative.

Configuring Specific License Reservation

Before configuring Specific License Reservation, connect with your account representative and complete the following tasks:

- Create a Smart Account.
- Enable your Smart Account for SLR.
- Get access to SLR PIDs in Cisco Commerce Workspace (CCW).
- Order SLR licenses in CCW and make sure they are available in your Smart Account on CSSM.

Enable Specific License Reservation feature of licensing using the **license smart reservation** command in the global configuration mode.

Workflow

Here is the list of configurations that should be executed in sequence to complete the SLR feature:

1. Enabling Specific License Reservation
2. Generating a Request Code from the Router
3. Reserving a SLR License in Cisco SSM
4. Registering a Router with the Authorization Code

Here is the list of configurations that are used to cancel, verify, remove, and return SLR:

- Cancelling a SLR Request
- Verifying the License Status After Cancelling SLR
- Removing SLR from a Router
- Generating a Return Code from a Router
- Removing the Product Instance from CSSM

Enabling Specific License Reservation

First, enable Flexible Consumption Model (FCM) of licensing. To enable FCM for your hardware, use the `license smart flexible-consumption enable` command in the global configuration mode.

Then, enable Specific License Reservation feature of licensing. In order to enable SLR feature, license reservation must be configured in the global configuration mode:

```
Router(config)# license smart reservation
```

Generating a Request Code from the Router

After enabling the SLR feature, use the `license smart reservation request local` command to generate a request code. Enter this code in CSSM.

Example:

```
RP/0/RSP0/CPU0:router# license smart reservation request local
Fri Mar 6 12:39:02.818 UTC
Enter this request code in the Cisco Smart Software Manager portal:
CD-ZNCS-5501-SE:FOC2118R24P-AVYd1FABK-AC /* This is a sample code */
```

Reserving a SLR License in Cisco SSM

This procedure shows how to generate an authorization code from CSSM portal:

SUMMARY STEPS

1. Go to Cisco SSM from <https://software.cisco.com>
2. Under **License** section, click **Smart Software Licensing**
3. Click the **Inventory** tab and from the **Virtual Account** drop-down list, choose your virtual account.
4. Go to **Licenses** tab and click **License Reservation**.

DETAILED STEPS

	Command or Action	Purpose
Step 1	Go to Cisco SSM from https://software.cisco.com	Log in to the Cisco SSM portal using the username and password provided by Cisco.
Step 2	Under License section, click Smart Software Licensing	
Step 3	Click the Inventory tab and from the Virtual Account drop-down list, choose your virtual account.	You can search by typing your virtual account name, or you can scroll the list and select your account name.
Step 4	Go to Licenses tab and click License Reservation .	The Smart License Reservation window appears. This window has four steps that should be performed in sequence to complete the procedure.

Registering a Router with the Authorization Code

This procedure shows how to register a router with the authorization code that is generated from CSSM:

```
Router# license smart reservation install [<> | file]
```

**Note**

- '<>' is the code itself or an alternative is to import from a file.
- 'file' option is preferred in those cases where the authorization code is long.

Example:

```
RP/0/RSP0/CPU0:router# license smart reservation install file
/disk2:/AuthorizationCode_SN_FOX24XXXXX.txt /* This is a sample code */
```

The "/" before the directory (/disk2:/ or /harddisk:/) is needed because of the linux file path.

The SLR license reservation is enabled, and the SL status changes to Authorized state.

The router stops using the evaluation period.

Verification

To verify the license status after the registration, use the **show license reservation** command:

```
RP/0/RSP0/CPU0:router# show license reservation
Fri Feb 5 16:35:37.340 UTC
License reservation: ENABLED
Overall status:
  Active: PID:NCS-55A2-MOD-S,SN:FOC2245R05H
           Reservation status: RESERVATION IN PROGRESS on Feb 05 2021 16:33:08 UTC
           Request code: CC-ZNCS-55A2-MOD-S:FOC2245R05H-AVYd1FABK-45
```

To cancel, verify, remove, and return SLR

Cancelling a SLR Request

The license reservation request code can be cancelled before or after an authorization code is generated. Note that the authorization file needs to be returned to Cisco SSM if the cancellation request is raised after an authorization code is generated from CSSM.

To cancel an SLR request before the authorization code is installed, perform this procedure:

```
RP/0/RSP0/CPU0:router# license smart reservation cancel local
Fri Feb 5 16:41:55.262 UTC
Reservation cancelled
```

Verifying the License Status After Cancelling SLR

To verify the status of license after cancelling SLR, use the **show license reservation** command:

```
RP/0/RSP0/CPU0:router# show license reservation
Fri Feb 5 16:41:58.284 UTC
License reservation: ENABLED
Overall status:
  Active: PID:NCS-55A2-MOD-S,SN:FOC2245R05H
```

```
Reservation status: NOT INSTALLED
Last return code: CQ8K5Y-gYxar7-baroN9-BH2d4X-EaG7bH-6L7QmQ-mEGwy3-fxSCxo-Dku
```

Removing SLR from a Router

To remove SLR from a router, perform the following tasks:

1. Generate a return code from a router.
2. Enter the return code on CSSM.
3. Remove the product instance.

Generating a Return Code from a Router

To generate a return code, use the **license smart reservation return** command:

To verify the license status after returning a license, use the **show license status** command:

```
Router# license smart reservation return [local]
```

The command prints the reservation return code that must be entered in the CSSM portal to return the license to the virtual pool.

Removing the Product Instance from CSSM

This procedure shows how to remove the product instance from CSSM portal:

SUMMARY STEPS

1. Go to Cisco SSM from <https://software.cisco.com>
2. Under **License** section, click **Smart Software Licensing**
3. Click the **Inventory** tab and from the **Virtual Account** drop-down list, choose your virtual account.
4. Click the **Product** instances tab.
5. Locate the required product instance from the product instances list. Optionally, you can enter a name or product type string in the search tab to locate the product instance.
6. Click the required product instance to expand the same.
7. From the **Actions** drop-down list, choose **Remove**.
8. In the **Reservation Return Code** field, enter the return code.
9. Click **Remove Product Instance**.

DETAILED STEPS

	Command or Action	Purpose
Step 1	Go to Cisco SSM from https://software.cisco.com	Log in to the Cisco SSM portal using the username and password provided by Cisco.
Step 2	Under License section, click Smart Software Licensing	
Step 3	Click the Inventory tab and from the Virtual Account drop-down list, choose your virtual account.	You can search by typing your virtual account name, or you can scroll the list and select your account name.

	Command or Action	Purpose
Step 4	Click the Product instances tab.	The list of product instances that are available is displayed.
Step 5	Locate the required product instance from the product instances list. Optionally, you can enter a name or product type string in the search tab to locate the product instance.	
Step 6	Click the required product instance to expand the same.	The Overview window is displayed.
Step 7	From the Actions drop-down list, choose Remove .	The Remove Product Instance window is displayed.
Step 8	In the Reservation Return Code field, enter the return code.	
Step 9	Click Remove Product Instance .	

The reservation information is removed, and the license is made available in the virtual account.

Configuration Examples for SLR

The following sections provide various SLR examples.

Enabling FCM

To enable FCM, use the **license smart flexible-consumption enable** command:

```
Router# configure
Router(config)# license smart flexible-consumption enable
Router(config)# exit
```

Enabling SLR

Before enabling SLR, you must enable Flexible Consumption Model (FCM) of licensing. To enable FCM for your hardware, use the **license smart flexible-consumption enable** command in the global configuration mode.

To enable SLR, use the **license smart reservation** command in the global configuration mode:

```
Router# configure
Router(config)# license smart reservation
Router(config)# exit
```

Viewing the License Information Before Registering

To display license entitlements, use the **show license all** command:

```
RP/0/RSP0/CPU0:router# show license all
Fri Feb 5 16:35:41.983 UTC

Smart Licensing Status
=====
Smart Licensing is ENABLED
License Reservation is ENABLED
```

```
Registration:
Status: RESERVATION IN PROGRESS
Export-Controlled Functionality: NOT ALLOWED
Reservation process started on: Feb 05 2021 16:33:08 UTC

License Authorization:
Status: EVAL MODE
Evaluation Period Remaining: 81 days, 21 hours, 24 minutes, 53 seconds

Export Authorization Key:
Features Authorized:
<none>

Utility:
Status: DISABLED

Data Privacy:
Sending Hostname: yes
Callhome hostname privacy: DISABLED
Smart Licensing hostname privacy: DISABLED
Version privacy: DISABLED

Transport:
Type: Transport Off

Miscellaneous:
Custom Id: <empty>

License Usage
=====
(ADV-100G-RTU-1):
Description:
Count: 1
Version: 1.0
Status: EVAL MODE
Export status: NOT RESTRICTED
Reservation:
Reservation status: NOT INSTALLED

(ADV-100G-SIA-3):
Description:
Count: 1
Version: 1.0
Status: EVAL MODE
Export status: NOT RESTRICTED
Reservation:
Reservation status: NOT INSTALLED

(ESS-100G-RTU-1):
Description:
Count: 1
Version: 1.0
Status: EVAL MODE
Export status: NOT RESTRICTED
Reservation:
Reservation status: NOT INSTALLED

(ESS-100G-SIA-3):
Description:
Count: 1
Version: 1.0
Status: EVAL MODE
Export status: NOT RESTRICTED
```



```
Reservation:
Reservation status: NOT INSTALLED

Product Information
=====
UDI: PID:NCS-55A2-MOD-S,SN:FOC2245R05H

Agent Version
=====
Smart Agent for Licensing: 5.1.8_rel/25

Reservation Info
=====
License reservation: ENABLED

Overall status:
Active: PID:NCS-55A2-MOD-S,SN:FOC2245R05H
  Reservation status: RESERVATION IN PROGRESS on Feb 05 2021 16:33:08 UTC
  Request code: CC-ZNCS-55A2-MOD-S:FOC2245R05H-AVYd1FABK-45
```

To display the license usage information, use the **show license usage** command:

```
RP/0/RSP0/CPU0:router# show license usage

Fri Feb 5 16:40:55.693 UTC

License Authorization:
Status: EVAL MODE
Evaluation Period Remaining: 81 days, 21 hours, 22 minutes, 46 seconds

(ADV-100G-RTU-1):
Description:
Count: 1
Version: 1.0
Status: EVAL MODE
Export status: NOT RESTRICTED
Reservation:
Reservation status: NOT INSTALLED

(ADV-100G-SIA-3):
Description:
Count: 1
Version: 1.0
Status: EVAL MODE
Export status: NOT RESTRICTED
Reservation:
Reservation status: NOT INSTALLED

(ESS-100G-RTU-1):
Description:
Count: 1
Version: 1.0
Status: EVAL MODE
Export status: NOT RESTRICTED
Reservation:
Reservation status: NOT INSTALLED

(ESS-100G-SIA-3):
Description:
Count: 1
Version: 1.0
Status: EVAL MODE
Export status: NOT RESTRICTED
Reservation:
```

Reservation status: NOT INSTALLED

To display all the license summaries, use the **show license summary** command:

```
RP/0/RSP0/CPU0:router# show license summary
```

Fri Feb 5 16:35:32.192 UTC

Smart Licensing is ENABLED
License Reservation is ENABLED

Registration:
Status: RESERVATION IN PROGRESS
Export-Controlled Functionality: NOT ALLOWED

License Authorization:
Status: EVAL MODE
Evaluation Period Remaining: 81 days, 21 hours, 25 minutes, 3 seconds

License Usage:

License	Entitlement Tag	Count	Status
	(ADV-100G-RTU-1)	1	EVAL MODE
	(ADV-100G-SIA-3)	1	EVAL MODE
	(ESS-100G-RTU-1)	1	EVAL MODE
	(ESS-100G-SIA-3)	1	EVAL MODE

To display the license status information, use the **show license status** command:

```
RP/0/RSP0/CPU0:router# show license status
```

Fri Feb 5 16:35:47.566 UTC

Smart Licensing is ENABLED

Utility:
Status: DISABLED
License Reservation is ENABLED

Data Privacy:
Sending Hostname: yes
Callhome hostname privacy: DISABLED
Smart Licensing hostname privacy: DISABLED
Version privacy: DISABLED

Transport:
Type: Transport Off

Registration:
Status: RESERVATION IN PROGRESS
Export-Controlled Functionality: NOT ALLOWED
Reservation process started on: Feb 05 2021 16:33:08 UTC

License Authorization:
Status: EVAL MODE
Evaluation Period Remaining: 81 days, 21 hours, 24 minutes, 47 seconds

Export Authorization Key:
Features Authorized:
<none>

Miscellaneous:
Custom Id: <empty>

Viewing the License Status After Registering

To display license entitlements, use the `show license all` command:

```
RP/0/RSP0/CPU0:router# show license all

Fri Feb 5 16:37:57.228 UTC

Smart Licensing Status
=====
Smart Licensing is ENABLED
License Reservation is ENABLED

Registration:
  Status: REGISTERED - SPECIFIC LICENSE RESERVATION
  Export-Controlled Functionality: ALLOWED
  Initial Registration: SUCCEEDED on Feb 05 2021 16:37:38 UTC

License Authorization:
  Status: AUTHORIZED - RESERVED on Feb 05 2021 16:37:38 UTC

Export Authorization Key:
  Features Authorized:
  <none>

Utility:
  Status: DISABLED

Data Privacy:
  Sending Hostname: yes
  Callhome hostname privacy: DISABLED
  Smart Licensing hostname privacy: DISABLED
  Version privacy: DISABLED

Transport:
  Type: Transport Off

Miscellaneous:
  Custom Id: <empty>

License Usage
=====
Core and Aggregation Advanced SW Right-to-Use v1.0 per 100G (ADV-100G-RTU-1):
  Description: Core and Aggregation Advanced SW Right-to-Use v1.0 per 100G
  Count: 1
  Version: 1.0
  Status: AUTHORIZED
  Export status: NOT RESTRICTED
  Reservation:
    Reservation status: SPECIFIC INSTALLED
    Total reserved count: 1

Core & Aggr Advanced SIA per 100G (ADV-100G-SIA-3):
  Description: Core & Aggr Advanced SIA per 100G
  Count: 1
  Version: 1.0
  Status: AUTHORIZED
  Export status: NOT RESTRICTED
  Reservation:
    Reservation status: SPECIFIC INSTALLED
    Total reserved count: 1

Core and Aggregation Essentials SW Right-to-Use v1.0 per 100G (ESS-100G-RTU-1):
  Description: Core and Aggregation Essentials SW Right-to-Use v1.0 per 100G
```

```

Count: 1
Version: 1.0
Status: AUTHORIZED
Export status: NOT RESTRICTED
Reservation:
    Reservation status: SPECIFIC INSTALLED
    Total reserved count: 1

Core & Aggr Essentials SIA per 100G (ESS-100G-SIA-3):
Description: Core & Aggr Essentials SIA per 100G
Count: 1
Version: 1.0
Status: AUTHORIZED
Export status: NOT RESTRICTED
Reservation:
    Reservation status: SPECIFIC INSTALLED
    Total reserved count: 1

Product Information
=====
UDI: PID:NCS-55A2-MOD-S,SN:FOC2245R05H

Agent Version
=====
Smart Agent for Licensing: 5.1.8_rel/25

Reservation Info
=====
License reservation: ENABLED

Overall status:
Active: PID:NCS-55A2-MOD-S,SN:FOC2245R05H
Reservation status: SPECIFIC INSTALLED on Feb 05 2021 16:37:38 UTC
Last Confirmation code: 21662953

Specified license reservations:
Core & Aggr Advanced SIA per 100G (ADV-100G-SIA-3):
Description: Core & Aggr Advanced SIA per 100G
Total reserved count: 1
Enforcement type: ENFORCED
Term information:
    Active: PID:NCS-55A2-MOD-S,SN:FOC2245R05H
    Authorization type: SPECIFIC INSTALLED on Feb 05 2021 16:37:38 UTC
    License type: TERM
    Start Date: 2020-SEP-11 UTC
    End Date: 2021-SEP-11 UTC
    Term Count: 1
Core & Aggr Essentials SIA per 100G (ESS-100G-SIA-3):
Description: Core & Aggr Essentials SIA per 100G
Total reserved count: 1
Enforcement type: ENFORCED
Term information:
    Active: PID:NCS-55A2-MOD-S,SN:FOC2245R05H
    Authorization type: SPECIFIC INSTALLED on Feb 05 2021 16:37:38 UTC
    License type: TERM
    Start Date: 2020-SEP-11 UTC
    End Date: 2021-SEP-11 UTC
    Term Count: 1
Core and Aggregation Advanced SW Right-to-Use v1.0 per 100G (ADV-100G-RTU-1):
Description: Core and Aggregation Advanced SW Right-to-Use v1.0 per 100G
Total reserved count: 1
Enforcement type: ENFORCED
Term information:
    Active: PID:NCS-55A2-MOD-S,SN:FOC2245R05H

```

```

Authorization type: SPECIFIC INSTALLED on Feb 05 2021 16:37:38 UTC
License type: TERM
  Start Date: 2021-JAN-11 UTC
  End Date: 2022-JAN-11 UTC
  Term Count: 1
Core and Aggregation Essentials SW Right-to-Use v1.0 per 100G (ESS-100G-RTU-1):
  Description: Core and Aggregation Essentials SW Right-to-Use v1.0 per 100G
  Total reserved count: 1
  Enforcement type: ENFORCED
  Term information:
    Active: PID:NCS-55A2-MOD-S,SN:FOC2245R05H
    Authorization type: SPECIFIC INSTALLED on Feb 05 2021 16:37:38 UTC
    License type: TERM
      Start Date: 2021-JAN-11 UTC
      End Date: 2022-JAN-11 UTC
      Term Count: 1

```

To display the license usage information, use the **show license usage** command:

```

RP/0/RSP0/CPU0:router# show license usage

Fri Feb 5 16:38:08.167 UTC

License Authorization:
  Status: AUTHORIZED - RESERVED on Feb 05 2021 16:37:38 UTC

Core and Aggregation Advanced SW Right-to-Use v1.0 per 100G (ADV-100G-RTU-1):
  Description: Core and Aggregation Advanced SW Right-to-Use v1.0 per 100G
  Count: 1
  Version: 1.0
  Status: AUTHORIZED
  Export status: NOT RESTRICTED
  Reservation:
    Reservation status: SPECIFIC INSTALLED
    Total reserved count: 1

Core & Aggr Advanced SIA per 100G (ADV-100G-SIA-3):
  Description: Core & Aggr Advanced SIA per 100G
  Count: 1
  Version: 1.0
  Status: AUTHORIZED
  Export status: NOT RESTRICTED
  Reservation:
    Reservation status: SPECIFIC INSTALLED
    Total reserved count: 1

Core and Aggregation Essentials SW Right-to-Use v1.0 per 100G (ESS-100G-RTU-1):
  Description: Core and Aggregation Essentials SW Right-to-Use v1.0 per 100G
  Count: 1
  Version: 1.0
  Status: AUTHORIZED
  Export status: NOT RESTRICTED
  Reservation:
    Reservation status: SPECIFIC INSTALLED
    Total reserved count: 1

Core & Aggr Essentials SIA per 100G (ESS-100G-SIA-3):
  Description: Core & Aggr Essentials SIA per 100G
  Count: 1
  Version: 1.0
  Status: AUTHORIZED
  Export status: NOT RESTRICTED
  Reservation:
    Reservation status: SPECIFIC INSTALLED
    Total reserved count: 1

```

To display all the license summaries, use the **show license summary** command:

```
RP/0/RSP0/CPU0:router# show license summary

Fri Feb 5 16:37:51.470 UTC

Smart Licensing is ENABLED
License Reservation is ENABLED

Registration:
  Status: REGISTERED - SPECIFIC LICENSE RESERVATION
  Export-Controlled Functionality: ALLOWED

License Authorization:
Status: AUTHORIZED - RESERVED

License Usage:
License                               Entitlement Tag                Count Status
-----
Core and Aggregation...               (ADV-100G-RTU-1)              1 AUTHORIZED
Core & Aggr Advanced...               (ADV-100G-SIA-3)              1 AUTHORIZED
Core and Aggregation...               (ESS-100G-RTU-1)              1 AUTHORIZED
Core & Aggr Essentia...               (ESS-100G-SIA-3)              1 AUTHORIZED
```

To display the license status information, use the **show license status** command:

```
RP/0/RSP0/CPU0:router# show license status

Fri Feb 5 16:38:03.370 UTC

Smart Licensing is ENABLED

Utility:
  Status: DISABLED
License Reservation is ENABLED

Data Privacy:
  Sending Hostname: yes
  Callhome hostname privacy: DISABLED
  Smart Licensing hostname privacy: DISABLED
  Version privacy: DISABLED

Transport:
  Type: Transport Off

Registration:
  Status: REGISTERED - SPECIFIC LICENSE RESERVATION
  Export-Controlled Functionality: ALLOWED
  Initial Registration: SUCCEEDED on Feb 05 2021 16:37:38 UTC

License Authorization:
  Status: AUTHORIZED - RESERVED on Feb 05 2021 16:37:38 UTC

Export Authorization Key:
  Features Authorized:
  <none>

Miscellaneous:
  Custom Id: <empty>
```



CHAPTER 16

Upgrading Field-Programmable Device

An FPD is a field programmable logic device which contains non-volatile, re-programmable memory to define its internal wiring and functionality. The contents of this non-volatile memory are called the FPD image or FPD firmware. Over the lifespan of an FPD, FPD firmware images may need upgrades for bug fixes or functionality improvements. These upgrades are performed in the field with minimum system impact.

- [Prerequisites for FPD Image Upgrades, on page 265](#)
- [Overview of FPD Image Upgrade Support, on page 265](#)
- [FPD upgrade service, on page 266](#)
- [YANG Data Model for Field Programmable Device, on page 276](#)

Prerequisites for FPD Image Upgrades

You must install the FPD pie before you install the SMUs or Service Packs. If you install the SMU or Service Packs before the FPD pie, the FPDs on the line card may not upgrade. In such cases, you must remove the SMUs and Service Packs and reload the router.

Overview of FPD Image Upgrade Support

An FPD image is used to upgrade the software on an FPD.

FPD versions must be compatible with the Cisco IOS XR software that is running on the router; if an incompatibility exists between an FPD version and the Cisco IOS XR software, the device with the FPGA may not operate properly until the incompatibility is resolved.



Note

- It is mandatory to upgrade all the required FPDs before doing a reload when you are upgrading FPDs on line cards. This is because, partial FPD component upgrades might result in booting errors (in some cases).
- You must not reload any line card or the router before all FPD image upgrades are completed successfully.

FPD upgrade service

The main tasks of the FPD upgrade service are:

- Check FPD image version to decide if a specific firmware image needs an upgrade or not.
- Manual FPD Image Upgrade using the **upgrade hw-module fpd** command.
- Invoke the appropriate device driver with a name of the new image to load.

An FPD image package is used to upgrade FPD images. The **install activate** command is used to place the FPD binary files into the expected location on the boot devices.

Supported Upgrade Methods

Method	Remarks
Manual Upgrade	Upgrade using CLI, force upgrade supported.

Determining Upgrade Requirement

Use the **show hw-module fpd** command to determine if an FPD upgrade is required. Check for NEED UPGD in the Status column.

Example

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

```
Wed Dec 14 07:08:08.424 UTC
```

```
Auto-upgrade:Disabled
```

Location	Card type	HWver	FPD device	ATR Status	FPD Versions	
					Running	Programd
0/0	NC55-18H18F	1.0	MIFPGA	NEED UPGD	7.01	7.01
0/0	NC55-18H18F	1.0	Bootloader	CURRENT	1.14	1.14
0/0	NC55-18H18F	1.0	IOFPGA	CURRENT	0.07	0.07
0/0	NC55-18H18F	1.0	SATA-M600-MCT	CURRENT	0.23	0.23

Use the **show fpd package** command to find out which FPGAs are supported with your current software release and minimum hardware requirements for each module.

Manual FPD upgrade

Manual FPD upgrade is performed using the **upgrade hw-module fpd** command. All cards or all FPGA in a card can be upgraded. If reload is required to activate FPD, the upgrade should be complete. Line-cards, fabric cards and RP cards cannot be reloaded during the process of the FPD upgrade.

FPD upgrade is transaction-based:

- Each fpd upgrade CLI execution is one transaction.
- Only one transaction is allowed at any given time.

- One transaction may include one or many FPD upgrades

The **force** option can be used to forcibly upgrade the FPD (regardless of whether it is required or not). It triggers all FPDs to be upgraded or downgraded. The **force** option can also be used to downgrade or upgrade the FPGAs even after the version check.



Note

- Sometimes, FPDs can have primary and backup images.
- Force FPD upgrade with **upgrade hw-module location all fpd all force** command affects forwarding over BVI interface. You must reload involved locations to recover.
- The use of the **force** option when performing an FPD upgrade is not recommended except under explicit direction from Cisco engineering or TAC for a one-time purpose only.
- FPD upgrade should be performed in Admin mode only.
- A new FPD upgrade should be issued only when previous FPD upgrades have been completed on the same FPD with the following syslog message:

```
RP/0/RP0/CPU0:May 10 10:11:44.414 UTC: fpd-serv[205]: %INFRA-FPD_Manager-1-UPGRADE_ALERT
: FPD Upgrade Completed (use "show hw-module fpd" to check upgrade status)
```

How to Upgrade FPD Images

You must determine if an FPD image upgrade is needed using the **show hw-module fpd** command and perform the upgrade, if needed, under the following circumstances:

- Migrate the software to a later Cisco IOS XR software release.
- Swap line cards from a system running a different Cisco IOS XR software release.
- Insert a new line card.

In the event of an FPD incompatibility with your card, you might receive the following error message:

```
LC/0/0/CPU0:Jul 5 03:00:18.929 UTC: optics_driver[220]: %L2-OPTICS-3-BAD_FPGA_IMAGE :
Detected bad MI FPGA image programmed in MI FPGA SPI flash in 0/0/CPU0 location: Failed to
validate meta data CRC
LC/0/0/CPU0:Jul 5 03:00:19.019 UTC: optics_driver[220]: %L2-OPTICS-3-BACKUP_FPGA_LOADED :
Detected Backup FPGA image running on 0/0/CPU0 - primary image corrupted (@0x8c = 0x44)
RP/0/RP0/CPU0:Jul 5 03:00:48.987 UTC: fpd-serv[301]: %PKT_INFRA-FM-3-FAULT_MAJOR : ALARM_MAJOR
: FPD-NEED-UPGRADE :DECLARE :0/0:
```

Upgrades to the Cisco IOS XR software might result in an FPD incompatibility. Ensure that you perform the FPD upgrade procedure and resolve all incompatibilities, for the cards to function properly.



Note

The use of the **force** option when performing a FPD upgrade is not recommended except under explicit direction from Cisco engineering or TAC for a one-time purpose only.

Before you begin

- The FPD upgrade procedure is performed while the card is online. At the end of the procedure the card must be reloaded before the FPD upgrade is complete. To reload the card, you can use the **hw-module location <location> reload** command in Admin mode, during the next maintenance window. The upgrade procedure is not complete until the card is reloaded.
- During the FPD upgrade, you *must not* do the following:
 - Reload, perform an online insertion and removal (OIR) of a line card (LC), or power down the chassis. Doing so may cause the node to enter an unusable state.
 - Press **Ctrl-C** if the console appears to hang without any output. Doing so may abort the upgrade.
- If you are not sure whether a card requires an FPD upgrade, you can install the card and use the **show hw-module fpd** command to determine if the FPD image on the card is compatible with the currently running Cisco IOS XR software release.

Procedure

	Command or Action	Purpose
Step 1	show hw-module fpd location {all node-id} Example: <pre>RP/0/RP0/CPU0:router# show hw-module fpd location all</pre> or <pre>RP/0/RP0/CPU0:router# show hw-module fpd location 0/4/cpu0</pre>	Displays the current FPD image versions for the specified card or all cards installed in the router. Use this command to determine if you must upgrade the FPD image on your card.
Step 2	admin Example: <pre>RP/0/RP0/CPU0:router# admin</pre>	Enters mode.
Step 3	(Optional) show fpd package Example:	Displays which cards are supported with your current Cisco IOS XR software release, which FPD image you need for each card, and what the minimum hardware requirements are for the various modules. (A minimum hardware requirement version of 0.0 indicates that all hardware can support this FPD image version.) If there are multiple FPD images for your card, use this command to determine which FPD image to use if you want to upgrade only a specific FPD type.
Step 4	upgrade hw-module fpd {all fpga-type} [force] location [all node-id] Example:	Upgrades all the current FPD images that must be upgraded on the specified card with new images. Before continuing to the next step, wait for confirmation that the FPD upgrade has successfully completed. Status

	Command or Action	Purpose
	<pre># upgrade hw-module fpd all location 0/3/1 . . . Successfully upgraded 1 FPD for SPA-2XOC48POS/RPR on location 0/3/1</pre>	<p>messages, similar to these, are displayed to the screen until the FPD upgrade is completed:</p> <pre>FPD upgrade started. FPD upgrade in progress.. FPD upgrade in progress.. FPD upgrade sent to location xxxx FPD upgrade sent to location yyyy FPD upgrade in progress.. FPD upgrade finished for location xxx FPD upgrade in progress.. FPD upgrade finished for location yyyy FPD upgrade completed.</pre> <p>The “FPD upgrade in progress.” message is printed every minute. These logs are information logs, and as such, are displayed if the logging console informational command is configured.</p> <p>If Ctrl-C is pressed while the FPD upgrade is in progress, the following warning message is displayed:</p> <pre>FPD upgrade in progress on some hardware, aborting now is not recommended as it might cause HW programming failure and result in RMA of the hardware. Do you want to continue? [Confirm(y/n)]</pre> <p>If you confirm that you want to abort the FPD upgrade procedure, this message is displayed:</p> <pre>FPD upgrade process has been aborted, please check the status of the hardware and reissue the upgrade command if required.</pre>

	Command or Action	Purpose
		<p>Note</p> <ul style="list-style-type: none"> • If your card supports multiple FPD images, you can use the show fpd package admin command to determine what specific image to upgrade in the upgrade hw-module fpd command. • A message is displayed when router modules cannot get upgraded during upgrade with location all option indicating that the FPGA is intentionally skipped during upgrade. To upgrade such FPGAs, you can use the CLI command with a particular location explicitly specified. For example, upgrade hw-module fpd all location 0/3/1. • It is recommended to upgrade all FPGAs on a given node using the upgrade hw-module fpd all location {all node-id} command. Do not upgrade the FPGA on a node using the upgrade hw-module fpd <individual-fpd> location {all node-id} as it may cause errors in booting the card.
Step 5	<p>exit</p> <p>Example:</p> <pre>sysadmin-vm:0_RP0# exit</pre>	
Step 6	<p>hw-module location { node-id all } reload</p>	<p>Use the hw-module location reload command to reload a line card.</p> <pre>sysadmin-vm:0_RP0# hw-module location 0/3 reload</pre>
Step 7	<p>exit</p>	
Step 8	<p>show hw-module fpd</p>	<p>Verifies that the FPD image on the card has been successfully upgraded by displaying the status of all FPDs in the system.</p>

Configuration Examples for FPD Image Upgrade

The following examples indicates the use of commands associated with the FPD image upgrade procedure.

show fpd package Command Output: Example

Use the **show fpd package** command in System Admin EXEC mode to find out which line cards are supported with your current Cisco IOS XR software release, which FPD image package you need for each line card, and what the minimum hardware requirements are for each module. If multiple FPD images are available for your card, they are listed as Subtype fpga2, fpga3, and so on.



Note The FPD name used in the FPD Description column of the output of the `show fpd package` command includes the last ten characters of DCO-PID. Depending on the slot and port numbers, the FPD name is appended with DCO_0, DCO_1, or DCO_2. For example, the FPD names for CFP2-WDM-D-1HL in port 0 and port 1 are -WDM-D-1HL_DCO_0 and WDM-D-1HL_DCO_1 respectively.



Note The FPD name used in the FPD Description column of the output of the `show fpd package` command displays QDD_instance_port-number. For example, depending on the instance and the port number, the FPD names for the QDD-400G-ZR-S and QDD-400G-ZRP-S modules will be QDD_0_3, QDD_1_0, and so on.

The following example shows sample output from the `show fpd package` command:

```
show fpd package
Tue Jan 22 13:56:00.212 UTC

=====
                          Field Programmable Device Package
=====
Card Type                FPD Description                Req   SW   Min Req  Min Req
Reload  Ver      SW Ver  Board Ver
=====
NC55-1200W-ACFW          LIT-PrimCU-ACFW (A)           NO    2.09  2.09    0.0
-----
NC55-900W-ACFW-I         LIT-PrimCU-ACFW-I (A)        NO    1.04  1.04    0.0
-----
NC55-900W-DCFW-I         LIT-PrimCU-DCFW-I (A)        NO    2.260 2.260  0.0
-----
NC55-930W-DCFW-C         LIT-PrimCU-DCFW-C (A)        NO    2.259 2.259  0.0
-----
NC55-MPA-12T-S           MPAFPGA                        YES    0.27  0.27    0.0
-----
NC55-MPA-1TH2H-S         -WDM-D-1HL_DCO_2              NO    38.518 38.518  0.1
MPAFPGA                  YES    0.53  0.53    0.0
WDM-DE-1HL_DCO_2        NO    38.518 38.518  0.1
WDM-DS-1HL_DCO_2        NO    38.268 38.268  0.1
-----
NC55-MPA-2TH-HX-S        -WDM-D-1HL_DCO_0              NO    38.518 38.518  0.1
-WDM-D-1HL_DCO_1        NO    38.518 38.518  0.1
MPAFPGA                  YES    0.53  0.53    0.0
WDM-DE-1HL_DCO_0        NO    38.518 38.518  0.1
WDM-DE-1HL_DCO_1        NO    38.518 38.518  0.1
WDM-DS-1HL_DCO_0        NO    38.268 38.268  0.1
WDM-DS-1HL_DCO_1        NO    38.268 38.268  0.1
-----
NC55-MPA-2TH-S           -WDM-D-1HL_DCO_0              NO    38.518 38.518  0.1
-WDM-D-1HL_DCO_1        NO    38.518 38.518  0.1
MPAFPGA                  YES    0.53  0.53    0.0
WDM-DE-1HL_DCO_0        NO    38.518 38.518  0.1
WDM-DE-1HL_DCO_1        NO    38.518 38.518  0.1
WDM-DS-1HL_DCO_0        NO    38.268 38.268  0.1
WDM-DS-1HL_DCO_1        NO    38.268 38.268  0.1
-----
NC55-MPA-4H-HD-S         MPAFPGA                        YES    0.53  0.53    0.0
-----
NC55-MPA-4H-HX-S         MPAFPGA                        YES    0.53  0.53    0.0
=====
```

show fpd package Command Output: Example

```

-----
NC55-MPA-4H-S      MPAFPGA          YES      0.53      0.53      0.0
-----
NC55A2-MOD-SE-H-S  Bootloader (A)   YES      1.11      1.11      0.0
                  CPU-IOFPGA (A)  YES      1.18      1.18      0.1
                  MB-IOFPGA (A)   YES      0.18      0.18      0.1
                  MB-MIFPGA        YES      0.19      0.19      0.0
                  SATA (A)         NO       5.00      5.00      0.0
-----
NCS-55A2-MOD-HD-S  Bootloader (A)   YES      1.11      1.11      0.0
                  CPU-IOFPGA (A)  YES      1.18      1.18      0.1
                  MB-IOFPGA (A)   YES      0.18      0.18      0.1
                  MB-MIFPGA        YES      0.19      0.19      0.0
                  SATA (A)         NO       5.00      5.00      0.0
-----
NCS-55A2-MOD-HX-S  Bootloader (A)   YES      1.11      1.11      0.0
                  CPU-IOFPGA (A)  YES      1.18      1.18      0.1
                  MB-IOFPGA (A)   YES      0.18      0.18      0.1
                  MB-MIFPGA        YES      0.19      0.19      0.0
                  SATA (A)         NO       5.00      5.00      0.0
-----
NCS-55A2-MOD-S     Bootloader (A)   YES      1.11      1.11      0.0
                  CPU-IOFPGA (A)  YES      1.18      1.18      0.1
                  MB-IOFPGA (A)   YES      0.18      0.18      0.1
                  MB-MIFPGA        YES      0.19      0.19      0.0
                  SATA (A)         NO       5.00      5.00      0.0
-----
NCS-55A2-MOD-SE-S  Bootloader (A)   YES      1.11      1.11      0.0
                  CPU-IOFPGA (A)  YES      1.18      1.18      0.1
                  MB-IOFPGA (A)   YES      0.18      0.18      0.1
                  MB-MIFPGA        YES      0.19      0.19      0.0
                  SATA (A)         NO       5.00      5.00      0.0
                  STATSFPGA       YES      0.01      0.01      0.0

```

This table describes the significant fields shown in the display:

Table 32: show fpd package Field Descriptions

Field	Description
Card Type	Module part number.
FPD Description	Description of all FPD images available for the line card.
Type	Hardware type. Possible types can be: <ul style="list-style-type: none"> • spa—Shared port adapter • lc—Line card
Subtype	FPD subtype. These values are used in the upgrade hw-module fpd command to indicate a specific FPD image type to upgrade.
SW Version	FPD software version recommended for the associated module running the current Cisco IOS XR software.
Min Req SW Vers	Minimum required FPD image software version to operate the card. Version 0.0 indicates that a minimum required image was not programmed into the card.

Field	Description
Min Req HW Vers	Minimum required hardware version for the associated FPD image. A minimum hardware requirement of version 0.0 indicates that all hardware can support this FPD image version.

upgrade hw-module fpd Command Output: Example

Use the **upgrade hw-module fpd** command to upgrade the FPD image on a line card. The upgrade can be executed for all FPDs or for specific FPDs that need an upgrade. To upgrade all FPDs, use **upgrade hw-module fpd all location all** command. To upgrade a specific FPD image type, use the FPD subtype value in the **upgrade hw-module fpd** command.

show platform Command Output: Example

Use the **show platform** command to verify that the line card is up and running.

Auto FPD Upgrade

Table 33: Feature History Table

Feature Name	Release Information	Feature Description
Auto FPD Upgrade	Release 7.3.2	This functionality enables automatic upgrade and reload for field-programmable devices (FPDs) whenever the Cisco IOS XR image has a newer FPD version. This functionality upgrades all route processors and line card FPDs simultaneously while displaying upgrade triggers on the console.

Effective Cisco IOS XR Release 7.3.2, you can enable automatic upgrade of FPD by using the “`fpd auto-upgrade enable`” command.

To automatically upgrade all FPDs, use:

```
RP/0/RP0/CPU0:IOS(config)#fpd auto-upgrade enable
```

To reload the interface modules following the `fpd auto-upgrade`, use:

```
RP/0/RP0/CPU0:IOS(config)#fpd auto-reload enable
```

Limitations and Usage Guidelines

Limitations

- FPD auto-upgrade should be enabled only in the XR VM and *not* in the System Admin VM.
- With auto-upgrade enabled, if any card is in RELOAD REQUIRED state, auto-upgrade is re-triggered during any SSO or FPD-serv process restart.

- When an interface module (IM) or route processor (RP) is in RELOAD REQUIRED state and auto-upgrade is enabled, FPD upgrades are triggered again.
- With auto-upgrade enabled, if line card is inserted, an auto-upgrade is triggered. During this phase optics alarms are generated. If auto-reload is not enabled, you must reload the line cards manually to clear these alarms.
- SATA allows you to upgrade or downgrade when an FPD version change is available. Therefore, when auto-upgrade is enabled, the system automatically downgrades if lower versions are available. This behavior is specific only to SATA FPDs.
- FPD auto-reload is applicable for line cards only. Line cards are automatically reloaded after the `fpd` auto-upgrade process is completed.
- Cisco NCS 5500 Series Routers do not support ISSU.
- TimingICs do not support **auto fpd upgrade** on NCS5500 Series Routers as the TimingIC requires a card reload immediately after upgrade. For the same reason, the TimingICs are not upgraded if the user specifies **location all** in the **auto fpd upgrade** command. To upgrade a TimingIC FPD, specify the FPD name along with the card location. For example, **upgrade hw-module fpd TimngIC-A location 0/RP0/cpu0**.
- Auto FPD upgrade is not supported on the following line cards that support QDD-400G-ZR-S and QDD-400G-ZRP-S modules:
 - NC57-24DD
 - NC57-18DD-SE
 - NC57-36H6D-S
 - NC57-48Q2D-S
 - NC57-MPA-2D4H-S
 - NC57-MOD-S
 - NC57-MPA-1FH1D-S

Usage Guidelines—Online Insertion of Line Cards

When a line card with a lower FPD version is inserted, one of the following scenarios apply:

- If `fpd` auto-upgrade and auto-reload are enabled, and a new line card is inserted, the system upgrades the line card FPDs automatically with the latest FPDs and reloads the line cards.
- If `fpd` auto-upgrade and auto-reload are both disabled, no action is required.
- If `fpd` auto-upgrade is enabled and auto-reload is disabled, the following alarms are displayed on the console:

```
RP/0/RP1/CPU0:Jun 1 10:05:46.095 UTC: optics_driver[231]: %PKT_INFRA-FM-3-FAULT_MAJOR
: ALARM_MAJOR :OPTICS SUPPORTED_ERROR :DECLARE : Optics0/5/0/6: Optics0/5/0/6
RP/0/RP1/CPU0:Jun 1 10:05:46.096 UTC: optics_driver[231]: %PKT_INFRA-FM-2-FAULT_CRITICAL
: ALARM_CRITICAL :OPTICS NOT SUPPORTED :DECLARE : Optics0/5/0/6: Optics0/5/0/6
```

You must reload the line cards manually to clear these alarms

Usage Guidelines—Online Insertion of RPs

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



Note RPs are not reloaded automatically. You must manually reload the RP or chassis for the latest FPD version to reflect.



Note Reload of active RPs and line cards impacts the network traffic.

Table 34: Action Required on FPDs After Auto Upgrade

FPD	Action Required
IOFPGA	Manual reload required
ADM	Upgraded version available immediately
PRIMARY-BIOS	Manual reload required
SATA	Upgraded version available immediately
PSOC	Upgraded version available immediately
IMFPGA	Manual reload required, if auto-reload is not configured

Automatic FPD Upgrade for PSU

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.

Upgrade Failure

On failure of an FPD upgrade, you get a warning with the following syslog message:

```
LC/0/5/CPU0:Jun 27 05:02:25.742 UTC: optics_driver[216]: %INFRA-FPD_Driver-1-UPGRADE_ALERT
: FPD MIFPGA@0/5 image programming completed with UPGD FAIL state Info: [Image verification
failed at offset 0x5c8, flash value = 0x0, image value = 0x40, image size = 4194304]
LC/0/5/CPU0:Jun 27 05:02:26.570 UTC: optics_driver[216]: %INFRA-FPD_Driver-1-UPGRADE_ALERT
: FPD MIFPGA@0/5 image programming completed with UPGD FAIL state Info: [Image verification
failed at offset 0x1e, flash value = 0x56, image value = 0xff, image size = 4194304]
```

When you use the **show hw-module fpd** command, the status column displays **UPGD FAIL** to indicate failure of the FPD upgrade.



Note

- Do not reload the line card with a failed FPD upgrade image.
- Upgrade failed FPDs will be fixed with a manual upgrade.
- Contact Cisco TAC or your account representative if the FPD upgrade failure is not repaired.

YANG Data Model for Field Programmable Device

Table 35: Feature History Table

Feature Name	Release Information	Description
Unified Model for FPD: Cisco-IOS-XR-um-fpd-cfg	Release 7.7.1	We have introduced the Cisco-IOS-XR-um-fpd-cfg unified model to enable or disable the automatic reload and automatic upgrade of Field Programmable Devices. You can access this unified model from the Github repository.

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

Operational Data	Native Data Model	CLI Commands
Auto Upgrade: Enabling or disabling of automatic upgrade of FPD.	Cisco-IOS-XR-fpd-infra-cfg.yang	<ul style="list-style-type: none"> • fpd auto-upgrade enable • fpd auto-upgrade disable
Auto Reload: Enabling or disabling of automatic reload of FPD.	Cisco-IOS-XR-fpd-infra-cfg.yang	<ul style="list-style-type: none"> • fpd auto-reload enable • fpd auto-reload disable

You can access the data models from the [Github](#) repository. To learn more about the data models and put them to use, see the *Programmability Configuration Guide for Cisco NCS 5500 Series Routers*.



CHAPTER 17

Y.1564 - Ethernet Service Activation Test

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- [CoS DEI Support Matrix, on page 281](#)
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- [Combined Frame Delay and Frame Loss Measurement for Y.1564 Service Activation Test, on page 289](#)

Y.1564 - Ethernet Service Activation Test

With the deployment of Ethernet in service provider networks, ethernet services have evolved significantly. Not only is ethernet found at the User Network Interface (UNI) but can also be deployed anywhere in the network, creating a Network-to-Network Interface (NNI). With the capability to prioritize traffic, high availability, and its built-in resiliency, service providers are now using this technology to deliver advanced services. In the absence of any standardized test methodologies that can measure delay, jitter, loss, and throughput at a port, the ITU-T recommendation Y.1564 addresses the gap

Y.1564 - Ethernet Service Activation Test (or performance test methodology) is a testing procedure which tests service turn-up, installation, and troubleshooting of Ethernet-based services. This test methodology was created to have a standard way of measuring Ethernet-based services in the industry.

This testing procedure is now supported on Cisco Routers that have the Cisco NCS57 line cards installed and operate in the Native mode.

On NCS 5700 Series NCS-57B1-5DSE-SYS/NCS-57B1-6D24-SYS fixed chassis, Service Activation/Deactivation Test (SAT/SADT) and its related features will not function for ETM-enabled optics controller interfaces.

Cisco implementation of ITU-T Y.1564 has three key objectives:

- To serve as a network SLA validation tool, ensuring that a service meets its guaranteed performance settings in a controlled test time.
- To ensure that all services carried by the network meet their SLA objectives at their maximum committed rate, thus proving that under maximum load, network devices and paths can support all traffic as designed.
- To perform medium-term and long-term service testing, confirming that network elements can properly carry all services while under stress during a soaking period.

The following Key Performance Indicators (KPI) metrics are collected to ensure that the configured SLAs are met for the service or stream.

- Frame Transfer Delay (FTD) or latency—Measures the round-trip time (RTT) taken by a test frame to travel through a network device, or across the network and back to the test port.
- Frame Loss Ratio (FLR)—Measures the number of packets lost from the total number of packets sent. Frame loss can be due to a number of issues such as network congestion or errors during transmissions.

Supported Modes

The mode of operation that is supported for Y.1564 is the Two-way statistics collection mode. In the two-way mode, the sender generates the test traffic used to perform the test, which is then looped back by the remote node. The statistics are measured and collected locally on the sender.

The following encapsulations are supported by Y.1564 SADT feature:

- dot1q
- dot1q + second dot1q
- dot1ad
- dot1ad + second dot1q
- priority tagged
- untagged



Note *Default encapsulation* is supported if there are no other sub-interfaces configured with *untagged encapsulation*.

Usage Guideline and Limitations

- Rewrite with POP option is supported with Color Blind mode with Outer-Cos value of 0.
- Rewrite Push and Translate on Encapsulation Untagged is not supported.
- Y.1564 doesn't support L1 loopback.
- Y.1564 over bundle with members from multiple NPU is not supported.
- Y.1564 doesn't support measuring and analyzing jitter.
- When utilizing the SAT engine Rx_bytes statistics feature, there can be potential inaccuracies in the following conditions:
 - During tests incorporating EMIX sequences that encounter packet drops.
 - When handling LMM packets originating from TGEN, Y.1731 protocols, or any unidentified sources.
- SAT supports a scale of four parallel sessions per system. However, all four sessions can not operate as color aware sessions simultaneously due to limitations in Class of Service (CoS) combinations.
- SAT over bundle interface functions by selecting one of its members for transmission. Therefore, at least one member must be in the 'UP' state to initiate an SAT session.

- For optimal performance, it's recommended to use the Ethernet Data Plane Loopback functionality (EDPL) on the peer side for SAT. EDPL loops back and swaps the MAC addresses of Layer 2 packets generated. If the peer node doesn't support EDPL functionality, you can configure SAT to generate Layer 2 packets with the destination MAC address equal to the source MAC address. In such cases, the peer can perform an L1 loopback.

CoS DEI Support Matrix

Table 36: Class of Service (CoS) and Discard Eligibility Identifier (DEI) Matrix

		CoS							
		0	1	2	3	4	5	6	7
DEI	0	Ö	Ö	Ö	Ö	Ö	X	Ö	X
	1	Ö	Ö	X	X	X	X	X	X

Ö - Supported

X- Not Supported

Supported Bandwidth Parameters

Bandwidth Parameters	Internal Direction	External Direction
Committed Information Rate	Y	Y
Exceeded Information Rate	Y	Y

Service Activation Test Target Matrix

Target	Internal Direction	External Direction
L2 Interface over physical main/sub interfaces	Y	Y
L2 Interface over bundle main/sub interfaces	Y	Y
L2 PW VPWS over physical main/sub interfaces	Y	Y
L2 PW VPWS over bundle main/sub interfaces	Y	Y
L2 EVPN/XConnect over physical main/sub interfaces	Y	Y

Target	Internal Direction	External Direction
L2 EVPN/XConnect over bundle main/sub interfaces	Y	Y
L2 VPLS PW	N	N
L2 EVPN Bridge-Domain	N	N
L3 Interfaces	N	N

Configuration Examples

The following example shows how to start service-activation test on an interface with external direction:

```
RP/0/RP0/CPU0:router ethernet service-activation-test start interface TenGigE 10/0/0/1
profile test destination 00ab.6009.9c3c direction external
```

The following example shows how to start service-activation test on an interface with internal direction:

```
RP/0/RP0/CPU0:router ethernet service-activation-test start interface TenGigE 10/0/0/1
profile test destination 00ab.6009.9c3c direction internal
```

The following example shows how to stop service-activation-test on an interface:

```
RP/0/RP0/CPU0:router ethernet service-activation-test stop interface TenGigE 10/0/0/1
```

The following example shows how to stop all service-activation-tests:

```
RP/0/RP0/CPU0:router ethernet service-activation-test stop all
```

Configuring Ethernet Service Activation Test Color Profile

The following example shows how to configure a color-blind profile for ethernet service activation test:

```
RP/0/RP0/CPU0:router#configure
RP/0/RP0/CPU0:router (config)# ethernet service-activation-test
RP/0/RP0/CPU0:router (config-ethsat)#profile sattest1
RP/0/RP0/CPU0:router (config-ethsat-prf)#outer-cos 4
RP/0/RP0/CPU0:router (config-ethsat-prf)#duration 8 minutes
RP/0/RP0/CPU0:router (config-ethsat-prf)#information-rate 11800 mbps
RP/0/RP0/CPU0:router (config-ethsat-prf)#packet-size 1000
```

The following example shows how to configure a color-aware profile for ethernet service activation test:

```
RP/0/RP0/CPU0:router#configure
RP/0/RP0/CPU0:router (config)# ethernet service-activation-test
RP/0/RP0/CPU0:router (config-ethsat)#profile sattest3
RP/0/RP0/CPU0:router (config-ethsat-prf)#outer-cos 4
RP/0/RP0/CPU0:router (config-ethsat-prf)#duration 1 minutes
RP/0/RP0/CPU0:router (config-ethsat-prf)#color-aware cir 7 gbps eir-color cos 1
RP/0/RP0/CPU0:router (config-ethsat-prf)#information-rate 8 gbps
RP/0/RP0/CPU0:router (config-ethsat-prf)#packet-size 1000
```


Verification

To verify the interfaces on which Y.1564 (ethernet service activation test) is enabled, use the **show ethernet service-activation-test brief** command. The following is a sample output of an enabled device:

```
RP/0/RP0/CPU0:router#show ethernet service-activation-test brief
Interface TenGigE0/0/0/14.1
  Service activation tests permitted (external only)
  Test completed:
    Duration 1 minute(s)
    Information rate 1 Gbps
    Color-aware, CIR: 900 Mbps, EIR: DEI set, CoS 1
    External, Two-way, Destination 00:11:00:22:00:33
    Packet size EMIX, Sequence 'abceg', Pattern hex 0x00
    Packet format: SAT MEF-49
    Outer CoS 2

Results:
  Step 1, Information Rate 1 Gbps
    CIR packets:
      Tx packets: 11276845, bytes: 6743553310
      Rx packets: 11276845, bytes: 6743553310
      FL: 0, FLR: 0%
      FD: Min 5.144us, Mean 6.681us, Max 9.576us
      IFDV: Not supported
      Out of order packets: 0 (0%)
      Error packets: 0 (0%)

    EIR packets:
      Tx packets: 1252895, bytes: 749231210
      Rx packets: 1252895, bytes: 749231210
      FL: 0, FLR: 0%
      FD: Min 5.160us, Mean 6.679us, Max 8.800us
      IFDV: Not supported
      Out of order packets: 0 (0%)
      Error packets: 0 (0%)
```

Optional Source MAC Address for Y.1564 Service Activation Test

Table 37: Feature History Table

Feature Name	Release Information	Feature Description
Optional Source MAC Address for Y.1564 Service Activation Test	Release 24.1.1	<p>Introduced in this release on: NCS 5500 fixed port routers; NCS 5700 fixed port routers</p> <p>By specifying the source MAC address to the ITU-T Y.1564 SAT, you can ensure that the test results are relevant and applicable to the specific service configuration for use in production and before deployment for your customers.</p> <p>This feature introduces the following change:</p> <p>Modified CLI:</p> <p>The source keyword is added to the ethernet service-activation-test command.</p> <p>YANG DATA Model:</p> <ul style="list-style-type: none"> New XPath for Cisco-IOS-XR-ethernet-sat-act.yang (see Github, YANG Data Models Navigator)

Prior to Cisco IOS XR Software Release 24.1.1, the default local interface MAC address was automatically employed as the source MAC address for the test traffic. This approach lacked flexibility and customization options, as you were restricted to the default address. With the optional source MAC address extension, you can specify the exact source MAC address you wish to use in the test traffic. This functionality empowers you to tailor the test sessions according to your specific requirements and network configurations.

Add Source MAC Address for a Y.1564 Service Activation Test

Use the **source** keyword in the **ethernet service-activation-test** command to specify a source MAC address for a Y.1564 Service Activation Test.

Step 1 Use the **ethernet service-activation-test** command to configure a profile.

```
Router(config)#ethernet service-activation-test
Router(config-ethsat)#profile prof1
```

```
Router(config-ethsat-prf)#duration 1 minutes
Router(config-ethsat-prf)#information-rate 1 mbps
Router(config-ethsat-prf)#root
Router(config)#interface TenGigE0/0/0/1
Router(config-if)#ethernet service-activation-test
Router(config-if-ethsat)#permit all
Router(config-if-ethsat)#commit
```

Step 2 Run the **ethernet service-activation-test** command in exec mode to specify source MAC address for an SAT:

```
Router#ethernet service-activation-test start interface TenGigE0/0/0/1 profile prof1 destination
00ab.6009.9c3c source 0000.1000.001d direction external
```

Step 3 The **show ethernet service-activation-test in-progress** command displays the source MAC address.

```
Router#show ethernet service-activation-test in-progress
Fri Oct 21 03:50:55.658 PDT
Interface TenGigE0/0/0/1
Service activation tests permitted
Test in progress, 1 minute(s) remaining:
  Duration 1 minute(s)
  Information rate 1 Mbps
  External, Two-way, Destination 00ab.6009.9c3c, Source 0000.1000.001d
```

Loopback Frames for Y.1564 Service Activation Test

Table 38: Feature History Table

Feature Name	Release Information	Feature Description
Loopback Frames for Y.1564 Service Activation Test	Release 24.1.1	<p>Introduced in this release on: NCS 5500 fixed port routers; NCS 5700 fixed port routers</p> <p>This feature enables the redirection of test traffic from the destination router to the source router in loopback message (LBM) format. Loopback message enables the measurement of various parameters and performance metrics, such as frame delay, frame loss rates, and QoS settings, after the traffic has completed its round trip.</p> <p>Such comprehensive measurement helps identify issues within the network setup. You can also use it to ensure the service is running and meets the SLA.</p> <p>This feature introduces the following change:</p> <p>CLI:</p> <p>The packet-format lbm keyword is added to the ethernet service-activation-test profile command.</p> <p>YANG DATA Model: New XPaths for Cisco-IOS-XR-ethernet-sat-cfg.yang (see Github, YANG Data Models Navigator)</p>

In a typical Y.1564 Service Activation Test scenario, traffic flows from a source router to a destination router. However, with the inclusion of the loopback-message packet-format configuration, the traffic that reaches the destination router can be redirected back to the source router through a loopback interface. Now, the data packets are used in LBM format.

The collection of statistics start once the source router receives the test traffic from the destination.

Prior to Cisco IOS XR Software Release 24.1.1, tests were conducted independently in each direction, with traffic flowing from the source to the destination router. The data packets were used in Loss Measurement Message (LMM) format for Frame Loss (FL).

To enable this functionality, use the **packet-format lbm** keyword in the **ethernet service-activation-test profile** command. Once **packet-format lbm** is configured, data packets are used as per MEF-49.

Configure Loopback for Test Traffic in a Y.1564 Service Activation Test

The following configuration example shows how to configure loopback frames for Y.1564 Service Activation Test.

Step 1 Use the **ethernet service-activation-test profile** command to configure loopback for a test traffic.

```
Router(config)#ethernet service-activation-test
Router(config-ethsat)#profile p1
Router(config-ethsat-prf)#duration 2 minutes
Router(config-ethsat-prf)#information-rate 5 gbps
Router(config-ethsat-prf)#packet-format lbm
Router(config-ethsat-prf)#root
Router(config)#interface TenGigE0/0/0/12
Router(config-if)#ethernet service-activation-test
Router(config-if-ethsat)#permit all
Router(config-if-ethsat)#commit
```

Example of SAT results:

```
Results:
Step 1, Information Rate 5 Gbps
CIR packets:
Tx packets: 313509436, bytes: 160516831232
Rx packets: 313464074, bytes: 160493605888
FL: 45362, FLR: 0%
FD: Min 5.244us, Mean 6.122us, Max 8.188us
IFDV: Not supported
Out of order packets: 0 (0%)
Error packets: 0 (0%)

EIR packets:
Tx packets: 0, bytes: 0
Rx packets: 0, bytes: 0
FL: 0, FLR: 0%
FD: Min 0.000us, Mean 0.000us, Max 0.000us
IFDV: Min 0.000us, Mean 0.000us, Max 0.000us
Out of order packets: 0 (0%)
Error packets: 0 (0%)
```

Step 2 Use the **show running-config** command for the running configuration

```
Router#show running-config
Wed Feb 14 14:37:59.418 UTC
!
ethernet service-activation-test
profile p1
  duration 2 minutes
  information-rate 5 gbps
  packet-format lbm
!
!
interface TenGigE0/0/0/12
ethernet service-activation-test
  permit all
!
```

Step 3 The `show ethernet service-activation-test` command shows that `packet-format lbm` is configured.

```
Router#show ethernet service-activation-test
Thu Feb 29 06:38:33.435 UTC
Interface TenGigE0/0/0/19
Service activation tests permitted
Test in progress, 179 minute(s) remaining:
Duration 2 minute(s)
Information rate 5 Gbps
Color-blind
External, Two-way, Destination 0A:AA:0B:BB:0C:CC
Packet size 512, Pattern hex 0x00
Packet format: Y.1731 LBM
CoS not set
```

Combined Frame Delay and Frame Loss Measurement for Y.1564 Service Activation Test

Table 39: Feature History Table

Feature Name	Release Information	Feature Description
Combined Frame Delay and Frame Loss Measurement for Y.1564 Service Activation Test	Release 24.1.1	<p>Introduced in this release on: NCS 5500 fixed port routers; NCS 5700 fixed port routers</p> <p>We have enhanced the ITU-T Y.1564 Service Activation Testing (SAT) capabilities by enabling a comprehensive service quality measurement that includes network responsiveness, congestion, and other issues degrading network performance. This feature also allows a holistic testing of the QoS SLAs, which helps identify potential issues faster and troubleshoot effectively.</p> <p>This feature introduces the following change:</p> <p>CLI:</p> <p>The measurement combined keyword is added to the ethernet service-activation-test profile command.</p> <p>YANG DATA Model:</p> <ul style="list-style-type: none"> New XPath for <code>Cisco-IOS-XR-ethernet-sat-cfg.yang</code> (see Github, YANG Data Models Navigator)

You can configure the SAT test to measure both delay and loss simultaneously for each frame transmitted and received. This configuration allows for the consolidated calculation of both delay and loss using Frame Delay (FD) packets. By setting the Frame Loss (FL) rate to 0% in the generator function, the test focuses solely on calculating delay and loss metrics using Delay Measurement Message (DMM) frames. This means that every frame sent and received is analyzed for delay and loss characteristics.

Prior to Cisco IOS XR Software Release 24.1.1 release, either FD or FL could be measured at a time

Furthermore, the configuration treats out-of-order packets in the same manner as the transmitted packets since there is no sequence numbering on the DMM packets. This approach ensures that all frames, regardless of their order of arrival, are accounted for in the measurement of delay and loss.

Configure Measurement Combined for a Y.1564 Service Activation Test

The following configuration example shows how to configure combined frame delay and frame loss measurements for Y.1564 Service Activation Test.

Step 1 Use the **ethernet service-activation-test profile** command to configure **measurement combined** for a test traffic.

```
Router(config)#ethernet service-activation-test
Router(config-ethsat)#profile p1
Router(config-ethsat-prf)#duration 10 minutes
Router(config-ethsat-prf)#information-rate 1 gbps
Router(config-ethsat-prf)#measurement combined
Router(config-ethsat-prf)#root
Router(config)#interface TenGigE0/0/0/12
Router(config-if)#ethernet service-activation-test
Router(config-if-ethsat)#permit all
Router(config-if-ethsat)#commit
```

Example of SAT results:

```
Results:
Step 1, Information Rate 1 Gbps
CIR packets:
Tx packets: 2929519174, bytes: 1499913817088
Rx packets: 20696794, bytes: 10596758528
FL: 2908822380, FLR: 99%
FD: Min 5.232us, Mean 18.642us, Max 63.032us
IFDV: Not supported
Out of order packets: 0 (0%)
Error packets: 0 (0%)

EIR packets:
Tx packets: 0, bytes: 0
Rx packets: 0, bytes: 0
FL: 0, FLR: 0%
FD: Min 0.000us, Mean 0.000us, Max 0.000us
IFDV: Min 0.000us, Mean 0.000us, Max 0.000us
Out of order packets: 0 (0%)
Error packets: 0 (0%)
```

Step 2 Use the **show running-configuration** command for the running configuration

```
Router#show running-config
Wed Feb 14 14:37:59.418 UTC
!
ethernet service-activation-test
profile p1
duration 10 minutes
information-rate 1 gbps
measurement combined
!
!
interface TenGigE0/0/0/12
ethernet service-activation-test
permit all
!
```

Step 3 The **show ethernet service-activation-test** command shows frame loss and frame delay are measured on every frame.


```
Router#show ethernet service-activation-test in-progress
Tue Dec 14 08:18:22.981 PST
Interface TenGigE0/0/0/12
  Service activation tests permitted
  Test in progress, 10 minute(s) remaining:
    Duration 10 minute(s)
    Information rate 1 gbps
    Color-blind
    External, Two-way, Destination Source 2001:DB8:0:ABCD::1
    Packet size 1024, Pattern hex 0x00
    Packet format: SAT MEF-48
    Delay and loss measured on every frame
    CoS not set
```



CHAPTER 18

Configuration and File System Management

This module describes methods for configuration management and file transfer enhancements.

- [Secure file transfer from the Router, on page 293](#)
- [Auto-Save Configuration, on page 296](#)

Secure file transfer from the Router

Table 40: 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.

Prerequisites:

Enable the SSH Server in the router as follows:

```
Router# config
Router(config)# ssh server v2
Router(config)# ssh server vrf default
Router(config)# ssh server netconf vrf default
Router(config)# commit
```

Configuration Example for Secure File Transfer Protocol

You can copy the running configuration file from the router to a remote server using SFTP:

Configuration in the Router

```
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
```

Configuration Example for Secure Copy Protocol

You can copy the running configuration file from the router to a remote server using SCP:

Configuration in the Router

```
Router# copy running-config scp://root:testpassword@192.0.4.2//var/opt/run_conf_scp.txt

Destination file name (control-c to cancel): [/var/opt/run_conf_scp.txt]?

.
215 lines built in 1 second
[OK]Connecting to 192.0.4.2...22
Password:

  Transferred 3271 Bytes
  3271 bytes copied in 0 sec (0)bytes/sec
```

Verification in the SCP Server

```
[root@scp_server ~]# ls -ltr /var/opt/run_conf_scp.txt
-rw-r--r-- 1 root root 3271 Mar 21 18:07 /var/opt/run_conf_scp.txt
```

Auto-Save Configuration

Table 41: Feature History Table

Feature Name	Release Information	Feature Description
Auto-Save with Secure File-Transfer and Additional Configurable Parameters	Release 7.9.1	<p>Apart from automatically backing up the running configuration after every commit, you can also do the following with Auto-Save:</p> <ul style="list-style-type: none"> • 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. <p>The feature introduces these changes:</p> <p>CLI: Modified the configuration commit auto-save command by adding the following keywords:</p> <ul style="list-style-type: none"> • filename scp • filename sftp • wait-time • timestamp • password • maximum <p>Yang Data Model:</p> <ul style="list-style-type: none"> • New XPath for Cisco-IOS-XR-config-autosave-cfg • New XPath 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 transferring large files.
- **password** - You 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.

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.

When filename is accessed through VRF, you can specify filename in **filename** <protocol>://<user>@<host>:<port>;<vrf name>/<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
!
```