### System Management Configuration Guide for Cisco ASR 9000 Series Routers, IOS XR Release 6.2.x

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Preface

From Release 6.1.2 onwards, Cisco introduces support for the 64-bit Linux-based IOS XR operating system. Extensive feature parity is maintained between the 32-bit and 64-bit environments. Unless explicitly marked otherwise, the contents of this document are applicable for both the environments. For more details on Cisco IOS XR 64 bit, refer to the Release Notes for Cisco ASR 9000 Series Routers, Release 6.1.2 document.

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 xvii
- Obtaining Documentation and Submitting a Service Request, on page xvii

Changes to This Document

This table lists the changes made to this document since it was first released.

Table 1: Changes to This Document

<table>
<thead>
<tr>
<th>Date</th>
<th>Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td>March 2017</td>
<td>Initial release of this document.</td>
</tr>
<tr>
<td>July 2017</td>
<td>Republished for Release 6.2.2.</td>
</tr>
</tbody>
</table>

Obtaining Documentation and Submitting a Service Request

For information on obtaining documentation, using the Cisco Bug Search Tool (BST), submitting a service request, and gathering additional information, see What's New in Cisco Product Documentation.

To receive new and revised Cisco technical content directly to your desktop, you can subscribe to the What's New in Cisco Product Documentation RSS feed. RSS feeds are a free service.
# 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 6.2.x, on page 1**

## System Management Features Added or Modified in IOS XR Release 6.2.x

<table>
<thead>
<tr>
<th>Feature</th>
<th>Description</th>
<th>Changed in Release</th>
<th>Where Documented</th>
</tr>
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<tbody>
<tr>
<td>Smart Licensing in Cisco IOS XR 64 bit</td>
<td>Smart Licensing support for A9K-MOD400-CM and A9K-20X10GE-CM line cards was introduced on Cisco IOS XR 64 bit.</td>
<td>Release 6.2.1</td>
<td>Smart Licensing in Cisco IOS XR 64 bit, on page 364</td>
</tr>
<tr>
<td>Frequency Synchronization support information</td>
<td>SyncE support extended to A9K-48X10GE-1G-SE/TR and A9K-24X10GE-1G-SE/TR line cards.</td>
<td>Release 6.2.1</td>
<td>Configuring Frequency Synchronization, on page 391</td>
</tr>
<tr>
<td>PTP Telecom Profile support</td>
<td>G.8275.2 profile support information updated. Support for the RSP IEEE 1588 port was added for the PIDs A99-RP2-SE and A99-RP2-TR.</td>
<td>Release 6.2.2</td>
<td>Configuring Precision Time Protocol, on page 403</td>
</tr>
</tbody>
</table>
CHAPTER 2

Configuring Profiles

Your router caters to different market segments on the service provider edge space. Your router is capable of supporting a wide range of market segments and features, but to make the software more efficient, you must configure the appropriate profiles to achieve the results you require.

• Different customers have different network architectures, and this puts different scale demands on the router. By configuring the scale profile, you can configure your router to accommodate your needs.

• The software supports a wide range of features. To optimize performance, each feature profile enables a subset of the total available features for a release. You must configure the appropriate profile to enable the features that you require.

Table 2: Feature History for Configuring Profiles

<table>
<thead>
<tr>
<th>Release</th>
<th>Modification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Release 3.9.1</td>
<td>The scale profile was introduced</td>
</tr>
<tr>
<td>Release 4.0.1</td>
<td>The scale profile configuration was moved to admin mode. The feature profile was introduced.</td>
</tr>
</tbody>
</table>

This model contains the following topics:

• Restrictions of Scale Profiles, on page 3
• Information About Profiles, on page 4
• How to Configure Profiles, on page 5
• Additional References, on page 10

Restrictions of Scale Profiles

Video monitoring is not supported with the L3XL scale profile.
Information About Profiles

Information About Scale Profiles

A scale profile is a user-configurable setting that tunes the router to perform more efficiently depending on how the router is being used. You should configure a scale profile before deploying the router to production use.

Your router can be used for different market segments on the service provider edge space. Because different customers have different network architectures, which can place different scale demands on the router, it is important to configure the scale profile so that your router works as efficiently as possible within the architecture that you are using.

Possible scenarios that are taken into account by the scale profile are:

• Use of the router as a Layer 2 transport device, thus requiring the support of high Layer 2 scale numbers.
• Use of the router primarily as a Layer 3 box that provides Layer 3 virtual private network (VPN) services, thus requiring the support of a high number of Layer 3 routes.

There are three scale profiles available on your router:

• The default scale profile that supports deployments that require large Layer 2 MAC tables (up to 512,000 entries) and a relatively small number of Layer 3 routes (less than 512,000).

• The Layer 3 scale profile that supports deployments that require more Layer 3 routes (up to 1 million) and smaller Layer 2 MAC tables (less than 128,000 entries).

• The Layer 3 XL scale profile that supports deployments that require a very large number of Layer 3 routes (up to 1.3 million) and minimal Layer 2 functionality. Note that the support for up to 1.3 million routes is split into IPv4 scaled support and IPv4/IPv6 scaled support. You can configure up to 1.3 million IPv4 routes, or up to 1 million IPv4 routes with 128,000 IPv6 routes. The layer 3 XL scale profile does not support video monitoring.

You can increase the memory available for BGP by configuring the Layer 3 XL profile on the Cisco ASR9000 Series Router using the `hw-module profile scale l3xl` command. However, this reduces the memory available for some other processes. To activate the new profile, you need to manually reboot the system.

The memory for BGP and the other processes can be verified by using the following commands before and after the configuration:

• `show processes memory detail`

• `show bgp process performance-statistics | include RLIMIT` : This command is available only from Cisco IOS-XR release 6.1.x onwards.

Information About Feature Profiles

To allow sufficient computation capabilities within the router, the available features within the Cisco IOS XR software image are bundled. A feature profile determines which bundle of features is available for you to use.
Although you can always configure a feature, if the feature is not supported by the active feature profile, you cannot use it.

There are two feature profiles available on your router:

- The default profile that supports all Cisco IOS XR software features except for IEEE 802.1ah provider backbone bridge (PBB).
- The Layer 2 profile that supports all Cisco IOS XR software features including IEEE 802.1ah PBB, but does not support IPv6, reverse-path forwarding (RPF) or netflow.

If the feature profile that you have configured on your router does not support a feature that you have configured, warning messages are displayed on the console, and the feature does not work. A configured feature profile takes affect only after you reload all the line cards on the router.

**Relationship Between Scale and Feature Profiles**

Although you are not limited in your selection of scale and feature profiles in relation to each other, Cisco recommends using the scale and feature profiles together as indicated here:

<table>
<thead>
<tr>
<th></th>
<th>Default Feature Profile</th>
<th>Layer 2 Feature Profile</th>
</tr>
</thead>
<tbody>
<tr>
<td>Default Scale Profile</td>
<td>Up to 512 K Layer 3 CEF&lt;sup&gt;1&lt;/sup&gt; scale</td>
<td>PPB&lt;sup&gt;2&lt;/sup&gt;</td>
</tr>
<tr>
<td>Layer 3 Scale Profile</td>
<td>Up to 1.0 M Layer 3 CEF scale</td>
<td>Not recommended</td>
</tr>
<tr>
<td></td>
<td>Less than 128 K MAC entries</td>
<td></td>
</tr>
<tr>
<td>Layer 3 XL Scale Profile</td>
<td>Up to 1.3 M Layer 3 CEF scale</td>
<td>Not recommended</td>
</tr>
</tbody>
</table>

<sup>1</sup> Cisco Express Forwarding  
<sup>2</sup> provider backbone bridge

Other pairs are not recommended. Note that the Layer 3 XL scale profile does not support video monitoring.

**How to Configure Profiles**

**Configuring the Scale Profile**

Before you deploy your router, you should configure the scale profile to make the system most efficient for your specific network architecture.

**Before you begin**

In general, the route switch processor (RSP) with 6 GB of memory is capable of loading 1.3 million IPv4 routes. For large scale routes like 4 million, 12 GB of memory is required.

The RSP440 supports 1.3 million IPv4 routes with the default memory.
The scale profile should be configured in the administration configuration. If you previously configured the L3 scale profile in the global configuration, the following limitations apply:

- If the scale profile is set only in the global configuration, the setting takes affect.
- Scale profile settings in the administration configuration override scale profile settings in the global configuration.
- Cisco recommends that you configure all scale profile settings in the administration configuration and remove the global configuration settings. For more information, refer to Removing the Scale Profile from the Global Configuration, on page 9.

SUMMARY STEPS

1. admin
2. configure
3. hw-module profile scale {default | l3 | l3xl}
4. commit
5. reload location all
6. show running-config
7. show hw-module profile

DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td>Enters administration EXEC mode.</td>
</tr>
<tr>
<td>admin</td>
<td>RP/0/RSP0/CPU0:router# admin</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>configure</td>
<td>Enters administration configuration mode.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>RP/0/RSP0/CPU0:router(config)# configure</td>
</tr>
<tr>
<td><strong>Step 3</strong></td>
<td>Specifies the scale profile for the router.</td>
</tr>
<tr>
<td>hw-module profile scale {default</td>
<td>l3</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>Sun Nov 14 10:04:27.109 PST</td>
</tr>
<tr>
<td></td>
<td>In order to activate this new memory resource profile, you must manually reboot the system.</td>
</tr>
</tbody>
</table>

- **default**—efficient for deployments that require large Layer 2 MAC tables (up to 512,000 entries) and a relatively small number of Layer 3 routes (less than 512,000).
- **l3**—efficient for deployments that require more Layer 3 routes (up to 1 million) and smaller Layer 2 MAC tables (less than 128,000 entries).
- **l3xl**—efficient for deployments that require a very large number of Layer 3 routes (up to 1.3 million) and minimal Layer 2 functionality. Note that the support
### Purpose

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>for up to 1.3 million routes is split into IPv4 scaled support and IPv4/IPV6 scaled support. You can configure up to 1.3 million IPv4 routes, or up to 1 million IPv4 routes with 128,000 IPv6 routes.</td>
</tr>
</tbody>
</table>

### Step 4

<table>
<thead>
<tr>
<th>Commit</th>
<th></th>
</tr>
</thead>
</table>

### Step 5

<table>
<thead>
<tr>
<th>Commit or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>reload location all</td>
<td>Reloads the entire router or all line cards in the chassis. If you are changing the scale profile to, or from, one of the Layer 3 scale profile values, you must perform a reload of the entire system before the change is enabled.</td>
</tr>
</tbody>
</table>

**Example:**

```
RP/0/RSP0/CPU0:router admins reload location all
```

### Step 6

<table>
<thead>
<tr>
<th>Commit or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>show running-config</td>
<td>Displays the configured scale profile.</td>
</tr>
</tbody>
</table>

**Example:**

```
RP/0/RSP0/CPU0:router admin show running-config
```

### Step 7

<table>
<thead>
<tr>
<th>Commit or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>show hw-module profile feature</td>
<td>Displays the active scale profile. If the scale profile is different than the configured profile, the line cards have not been reloaded as required for the scale profile configuration to take place.</td>
</tr>
</tbody>
</table>

**Example:**

```
RP/0/RSP0/CPU0:router admin show hw-module profile scale
```

---

## Configuring the Feature Profile

Before deploying your router you should determine that the feature profile is consistent with the features that you need to use. If it is not, use this task to configure a different profile.

### SUMMARY STEPS

1. `admin`
2. `configure`
3. `hw-module profile feature {default | l2}`
4. `commit`
5. `reload location {all | node-id}`
6. `show running-config`
7. `show hw-module profile feature`

### DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1 admin</td>
<td>Enters administration EXEC mode.</td>
</tr>
</tbody>
</table>

**Example:**

```
RP/0/RSP0/CPU0:router admin
```
<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 2</strong> configure</td>
<td>Enters administration configuration mode.</td>
</tr>
<tr>
<td>Example: RP/0/RSP0/CPU0:router(admin)# configure</td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong> hw-module profile feature {default</td>
<td>l2}</td>
</tr>
<tr>
<td>Example: RP/0/RSP0/CPU0:router(config)# hw-module profile feature l2</td>
<td>- <strong>default</strong>—supports all features except provider backbone bridge (PBB).</td>
</tr>
<tr>
<td></td>
<td>- <strong>l2</strong>—supports PBB, but does not support IPv6, reverse-path forwarding (RPF) and netflow.</td>
</tr>
<tr>
<td><strong>Step 4</strong> commit</td>
<td></td>
</tr>
<tr>
<td><strong>Step 5</strong> reload location {all</td>
<td>node-id}</td>
</tr>
<tr>
<td>Example: RP/0/RSP0/CPU0:router(config)# reload location 0/0/cpu0</td>
<td></td>
</tr>
<tr>
<td><strong>Step 6</strong> show running-config</td>
<td>Displays the configured feature profile.</td>
</tr>
<tr>
<td>Example: RP/0/RSP0/CPU0:router(config)# show running-config hw-module profile feature</td>
<td></td>
</tr>
<tr>
<td><strong>Step 7</strong> show hw-module profile feature</td>
<td>Displays the active feature profile. If the active profile is different from the configured profile, the line cards have not been reloaded as required for the feature profile configuration to take place.</td>
</tr>
<tr>
<td>Example: RP/0/RSP0/CPU0:router# show hw-module profile feature all</td>
<td></td>
</tr>
</tbody>
</table>

**What to do next**

If you see warning messages to the console indicating that the active feature profile does not match the configured profile, you must reload the affected line card so that the configured profile matches the active profile.

LC/0/1/CPU0:Nov 5 02:50:42.732 : prn_server[236]: Configured 'hw-module profile feature l2' does not match active 'hw-module profile feature default'. You must reload this line card in order to activate the configured profile on this card or you must change the configured profile.

If you see warning messages to the console indicating that some features do not match the feature profile, you should either change the feature profile configuration, or remove the non-supported features.
Removing the Scale Profile from the Global Configuration

If a scale profile is configured in the global configuration, you should duplicate the configuration in the administration configuration, and remove the global configuration as described here.

**Note**

If you do not move the scale profile setting to the administration configuration, the configuration in global configuration mode takes affect.

If the scale profile is configured in both the global configuration and administration configuration, the setting in the administration configuration takes precedence.

**SUMMARY STEPS**

1. `show running-config | file new-config-file`
2. Remove the line with the command `hw-module profile scale` from the file created in the previous step.
3. `configure`
4. `load new-config-file`
5. `commit replace`

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td>Copies the contents of the running configuration to a file.</td>
</tr>
<tr>
<td>`show running-config</td>
<td>file new-config-file`</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>`RP/0/RSP0/CPU0:router# show running-config</td>
<td>file new-config-file`</td>
</tr>
<tr>
<td><strong>Step 2</strong></td>
<td>Takes out the profile command that is configured in the global configuration.</td>
</tr>
<tr>
<td>Remove the line with the command <code>hw-module profile scale</code> from the file created in the previous step.</td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong></td>
<td>Replaces the running configuration with the edited file.</td>
</tr>
<tr>
<td><code>configure</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 4</strong></td>
<td>Commits the changed configuration to the router.</td>
</tr>
<tr>
<td><code>load new-config-file</code></td>
<td></td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td><code>RP/0/RSP0/CPU0:router(config)# load new-config-file</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 5</strong></td>
<td></td>
</tr>
<tr>
<td><code>commit replace</code></td>
<td></td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td><code>RP/0/RSP0/CPU0:router(config)# commit replace</code></td>
<td></td>
</tr>
</tbody>
</table>
## Additional References

### Related Documents

<table>
<thead>
<tr>
<th>Related Topic</th>
<th>Document Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Profile commands</td>
<td>Hardware Redundancy and Node Administration on the Cisco ASR 9000 Series Router module of System Management Command Reference for Cisco ASR 9000 Series Routers</td>
</tr>
<tr>
<td>Cisco IOS XR master command index</td>
<td>Cisco ASR 9000 Series Aggregation Services Router Commands Master List</td>
</tr>
<tr>
<td>Information about user groups and task IDs</td>
<td>Configuring AAA Services on the Cisco ASR 9000 Series Router module of System Security Configuration Guide for Cisco ASR 9000 Series Routers</td>
</tr>
</tbody>
</table>

### Standards and RFCs

<table>
<thead>
<tr>
<th>Standard/RFC</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No new or modified standards are supported by this feature, and support for existing standards has not been modified by this feature.</td>
</tr>
</tbody>
</table>

### MIBs

<table>
<thead>
<tr>
<th>MIB</th>
<th>MIBs Link</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>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: <a href="http://cisco.com/public/sw-center/netmgmt/cmtk/mibs.shtml">http://cisco.com/public/sw-center/netmgmt/cmtk/mibs.shtml</a></td>
</tr>
</tbody>
</table>

### Technical Assistance

<table>
<thead>
<tr>
<th>Description</th>
<th>Link</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Cisco Support website provides extensive online resources, including documentation and tools for troubleshooting and resolving technical issues with Cisco products and technologies. &lt;br&gt; &lt;br&gt; To receive security and technical information about your products, you can subscribe to various services, such as the Product Alert Tool (accessed from Field Notices), the Cisco Technical Services Newsletter, and Really Simple Syndication (RSS) Feeds. &lt;br&gt; &lt;br&gt; Access to most tools on the Cisco Support website requires a Cisco.com user ID and password.</td>
<td><a href="http://www.cisco.com/cisco/web/support/index.html">http://www.cisco.com/cisco/web/support/index.html</a></td>
</tr>
</tbody>
</table>
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.

Table 4: Feature History for Configuring Manageability on Cisco IOS XR Software

<table>
<thead>
<tr>
<th>Release 3.7.2</th>
<th>This feature was introduced</th>
</tr>
</thead>
<tbody>
<tr>
<td>Release 3.9.0</td>
<td>The ability to enable XML requests over Secure Socket Layer (SSL) was introduced.</td>
</tr>
<tr>
<td></td>
<td>The ability to configure an idle timeout for the XML agent was introduced.</td>
</tr>
<tr>
<td>Release 4.0.0</td>
<td>The ability to configure a dedicated agent to receive and send messages via a specified VPN routing and forwarding (VRF) instance was introduced.</td>
</tr>
<tr>
<td></td>
<td>The ability to control CPU time used by the XML agent was introduced.</td>
</tr>
</tbody>
</table>

This module contains the following topics:

• Information About XML Manageability, on page 11
• How to Configure Manageability, on page 12
• Configuration Examples for Manageability, on page 13
• Additional References, on page 13

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

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 { default | vrf-name } [ access-list access-list-name ]

DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td>Enables Extensible Markup Language (XML) requests over a dedicated TCP connection and enters XML agent configuration mode. Use the <strong>ssl</strong> keyword to enable XML requests over Secure Socket Layer (SSL).</td>
</tr>
<tr>
<td><strong>xml agent [ssl]</strong></td>
<td>RGB/0/RSP0/CPU0:router:router(config)# xml agent</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>RGB/0/RSP0/CPU0:router:router(config)# xml agent</td>
</tr>
<tr>
<td><strong>Step 2</strong></td>
<td>Configures the iteration size for large XML agent responses in KBytes. The default is 48.</td>
</tr>
<tr>
<td><strong>iteration on size iteration-size</strong></td>
<td>RGB/0/RSP0/CPU0:router:router(config-xml-agent)# iteration on size 500</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>RGB/0/RSP0/CPU0:router:router(config-xml-agent)# iteration on size 500</td>
</tr>
<tr>
<td><strong>Step 3</strong></td>
<td>Configures an idle timeout for the XML agent in minutes. By default, there is no timeout.</td>
</tr>
<tr>
<td><strong>session timeout timeout</strong></td>
<td>RGB/0/RSP0/CPU0:router:router(config-xml-agent)# session timeout 5</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>RGB/0/RSP0/CPU0:router:router(config-xml-agent)# session timeout 5</td>
</tr>
<tr>
<td><strong>Step 4</strong></td>
<td>Configures the XML agent processing capabilities.</td>
</tr>
<tr>
<td>**throttle { memory size</td>
<td>process-rate tags }**</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>RGB/0/RSP0/CPU0:router:router(config-xml-agent)# throttle memory 300</td>
</tr>
<tr>
<td><strong>Step 5</strong></td>
<td>Configures the dedicated agent or SSL agent to receive and send messages via the specified VPN routing and forwarding (VRF) instance.</td>
</tr>
<tr>
<td>**vrf { default</td>
<td>vrf-name } [ access-list access-list-name ]**</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>RGB/0/RSP0/CPU0:router:router(config-xml-agent)# vrf default access-list access-list-name</td>
</tr>
</tbody>
</table>
### 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/RSP0/CPU0:router# router(config)# xml agent
RP/0/RSP0/CPU0:router(config)# vrf VRF1
RP/0/RSP0/CPU0:router(config)# vrf VRF2
```

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

```
RP/0/RSP0/CPU0:router# router(config)# xml agent
RP/0/RSP0/CPU0:router(config)# no vrf VRF2
```

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/RSP0/CPU0:router# router(config)# xml agent ssl
RP/0/RSP0/CPU0:router(config)# vrf VRF1
RP/0/RSP0/CPU0:router(config)# vrf VRF2
```

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

```
RP/0/RSP0/CPU0:router# router(config)# xml agent ssl
RP/0/RSP0/CPU0:router(config)# no vrf VRF2
```

### Additional References

The following sections provide references related to configuring manageability on Cisco IOS XR software.

#### Related Documents

<table>
<thead>
<tr>
<th>Related Topic</th>
<th>Document Title</th>
</tr>
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<tr>
<td>Cisco IOS XR commands</td>
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<td>To locate and download MIBs for selected platforms, Cisco IOS releases, and feature sets, use Cisco MIB Locator found at the following URL:</td>
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<tr>
<td>—</td>
<td><a href="http://www.cisco.com/go/mibs">http://www.cisco.com/go/mibs</a></td>
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</table>

### RFCs

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<td><a href="http://www.cisco.com/cisco/web/support/index.html">http://www.cisco.com/cisco/web/support/index.html</a></td>
</tr>
</tbody>
</table>
Configuring Physical and Virtual Terminals

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

Before creating or modifying the vty pools, enable the telnet server using the `telnet server` command in Global Configuration mode. See IP Addresses and Services Configuration Guide for Cisco ASR 9000 Series Routers and IP Addresses and Services Command Reference for Cisco ASR 9000 Series Routers for more information.

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

For more information about physical and virtual terminals on the Cisco IOS XR software and complete descriptions of the terminal services commands listed in this module, see Related Documents, on page 24. To locate documentation for other commands that might appear in the course of running a configuration task, search online in Cisco ASR 9000 Series Aggregation Services Router Commands Master List.

**Table 5: Feature History for Implementing Physical and Virtual Templates on Cisco IOS XR Software**

<table>
<thead>
<tr>
<th>Release</th>
<th>Modification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Release 3.7.2</td>
<td>This feature was introduced.</td>
</tr>
<tr>
<td>Release 3.9.0</td>
<td>No modification.</td>
</tr>
</tbody>
</table>

This module contains the following topics:

- Prerequisites for Implementing Physical and Virtual Terminals, on page 16
- Information About Implementing Physical and Virtual Terminals, on page 16
- How to Implement Physical and Virtual Terminals on Cisco IOS XR Software, on page 18
- Craft Panel Interface, on page 22
- Configuration Examples for Implementing Physical and Virtual Terminals, on page 22
- Additional References, on page 24
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.

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 Global Configuration 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/RSP0/CPU0:router(config)# line console
RP/0/RSP0/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.

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

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

The default settings for the default template are described for all commands in line template configuration mode in the *Terminal Services Commands on the Cisco ASR 9000 Series Router* module in *System Management Command Reference for Cisco ASR 9000 Series Routers*.

---

**Note**

Before creating or modifying the vty pools, enable the telnet server using the `telnet server` command in Global Configuration mode. See *IP Addresses and Services Configuration Guide for Cisco ASR 9000 Series Routers* and *IP Addresses and Services Command Reference for Cisco ASR 9000 Series Routers* for more information.

---

**Terminal Identification**

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

**vty Pools**

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

- Default vty pool—The default vty pool consists of five vtys (vtys 0 through 4) that each reference the default line template.
- Default fault manager pool—The default fault manager pool consists of six vtys (vtys 100 through 105) that each reference the default line template.
In addition to the default vty pool and default fault manager pool, you can also configure a user-defined vty pool that can reference the default template or a user-defined template.

When configuring vty pools, follow these guidelines:

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

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

Modifying Templates

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

SUMMARY STEPS

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

DETAILED STEPS

<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1</td>
<td>configure</td>
<td>Enters line template configuration mode for the specified line template.</td>
</tr>
<tr>
<td>Step 2</td>
<td>line {console</td>
<td>default}</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>RP/0/RSP0/CPU0:router(config)# line console or</td>
<td></td>
</tr>
<tr>
<td></td>
<td>RP/0/RSP0/CPU0:router(config)# line default</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• console — Enters line template configuration mode for the console template.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• default — Enters line template configuration mode for the default line template.</td>
</tr>
</tbody>
</table>
Creating and Modifying vty Pools

This task explains how to create and modify vty pools.

You can omit Step 3, on page 20 to Step 5, on page 20 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. vty-pool {default | pool-name | eem} first-vty last-vty [line-template {default | template-name}]
7. commit

---

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 3</strong></td>
<td>Configure the terminal attribute settings for the specified template using the commands in line template configuration mode.</td>
</tr>
</tbody>
</table>
| **Step 4** | Use one of the following commands:  
- end  
- commit  
**Example:**  
RP/0/RSP0/CPU0:router(config-line)# end  
or  
RP/0/RSP0/CPU0:router(config-line)# commit |
| **Purpose** | Saves configuration changes.  
- When you issue the `end` command, the system prompts you to commit changes:  
  Uncommitted changes found, commit them before exiting(yes/no/cancel)? [cancel]:  
  - Entering `yes` saves configuration changes to the running configuration file, exits the configuration session, and returns the router to EXEC mode.  
  - Entering `no` exits the configuration session and returns the router to EXEC mode without committing the configuration changes.  
  - Entering `cancel` leaves the router in the current configuration session without exiting or committing the configuration changes.  
- Use the `commit` command to save the configuration changes to the running configuration file and remain within the configuration session. |
### Detailed Steps

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Configure</strong></td>
<td><strong>Step 1</strong> specifies the number of allowable Telnet servers. Up to 100 Telnet servers are allowed.</td>
</tr>
<tr>
<td><strong>Step 2</strong> telnet [ipv4</td>
<td>ipv6] server max-servers limit</td>
</tr>
<tr>
<td>Example:</td>
<td>RP/0/RSP0/CPU0:router(config)# telnet ipv4 server max-servers 10</td>
</tr>
</tbody>
</table>

**Note** By default no Telnet servers are allowed. You must configure this command in order to enable the use of Telnet servers.

**Step 3** line template template-name | Enters line template configuration mode for a user-defined template. |
| Example: | RP/0/RSP0/CPU0:router(config)# line template 1 |

**Step 4** Configure the terminal attribute settings for the specified line template using the commands in line template configuration mode. |

**Step 5** exit | Exits line template configuration mode and returns the router to global configuration mode. |
| Example: | RP/0/RSP0/CPU0:router(config-line)# exit |

**Step 6** vty-pool [default | pool-name | eem] first-vty last-vty [line-template [default | template-name]] | Creates or modifies vty pools. |
| Example: | RP/0/RSP0/CPU0:router(config)# vty-pool default 0 5 line-template default |
| or | RP/0/RSP0/CPU0:router(config)# vty-pool pool1 5 50 line-template template1 |
| or | RP/0/RSP0/CPU0:router(config)# vty-pool eem 100 105 line-template template1 |

- **default** — Configures the default vty pool.
  - The default vty pool must start at vty 0 and must contain a minimum of five vtys (vty 0 through 4).
  - You can resize the default vty pool by increasing the range of vtys that compose the default vty pool.

- **pool-name** — Creates a user-defined vty pool.
  - A user-defined pool must start at least at vty 5, depending on whether the default vty pool has been resized.
  - If the range of vtys for the default vty pool has been resized, use the first range value free from the default line template. For example, if the range of vtys for the default vty pool has been configured to include 10 vtys (vty 0 through 9),
<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>the range value for the user-defined vty pool must start with vty 10.</td>
</tr>
<tr>
<td>• eem — Configures the embedded event manager pool.</td>
<td></td>
</tr>
<tr>
<td>• The default embedded event manager vty pool must start at vty 100 and must contain a minimum of six vtys (vtys 100 through 105).</td>
<td></td>
</tr>
<tr>
<td>• line-template template-name — Configures the vty pool to reference a user-defined template.</td>
<td></td>
</tr>
</tbody>
</table>

### 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.

#### 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

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1</td>
<td>Displays the terminal parameters of terminal lines.</td>
</tr>
<tr>
<td>(Optional) `show line [aux location node-id</td>
<td>console location node-id</td>
</tr>
<tr>
<td>Example:</td>
<td>Specifies the <code>show line aux location node-id</code> EXEC command displays the terminal parameters of the auxiliary line.</td>
</tr>
<tr>
<td></td>
<td>Specifies the <code>show line console location node-id</code> EXEC command displays the terminal parameters of the console.</td>
</tr>
<tr>
<td></td>
<td>For the <code>location node-id</code> keyword and argument, enter the location of the Route Processor (RP) on which the respective auxiliary or console port resides.</td>
</tr>
<tr>
<td></td>
<td>The <code>node-id</code> argument is expressed in the format of <code>rack/slot/module</code>.</td>
</tr>
</tbody>
</table>
### Craft Panel Interface

The Craft Panel is an easily-accessible and user-friendly interface which assists the field operator in troubleshooting the router. It consists of a LCD display and three LEDs. The LEDs indicate minor, major and critical alarms.

For more details of the Craft Panel Interface, refer the *Hardware and System set-up guides*.

### 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:

```plaintext
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/RSP0/CPU0:router# show line console location 0/0/CPU0
```

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

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

**Modifying the Default Template: Example**

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

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

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

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

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

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

```
line template test
  exec-timeout 100 0
```
Configuring a User-Defined Template to Reference a User-Defined vty Pool: Example

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

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

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

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

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

Additional References

The following sections provide references related to implementing physical and virtual terminals on Cisco IOS XR software.

### Related Documents

<table>
<thead>
<tr>
<th>Related Topic</th>
<th>Document Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cisco IOS XR terminal services commands</td>
<td>Terminal Services Commands on the Cisco ASR 9000 Series Router module of System Management Command Reference for Cisco ASR 9000 Series Routers</td>
</tr>
<tr>
<td>Cisco IOS XR command master index</td>
<td>Cisco ASR 9000 Series Aggregation Services Router Commands Master List</td>
</tr>
<tr>
<td>Information about getting started with Cisco IOS XR software</td>
<td>Cisco ASR 9000 Series Aggregation Services Router Getting Started Guide</td>
</tr>
</tbody>
</table>
### Standards

<table>
<thead>
<tr>
<th>Standards</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>No new or modified standards are supported by this feature, and support for existing standards has not been modified by this feature.</td>
<td>—</td>
</tr>
</tbody>
</table>

### MIBs

<table>
<thead>
<tr>
<th>MIBs</th>
<th>MIBs Link</th>
</tr>
</thead>
<tbody>
<tr>
<td>—</td>
<td>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: <a href="http://cisco.com/public/sw-center/netmgmt/cmtk/mibs.shtml">http://cisco.com/public/sw-center/netmgmt/cmtk/mibs.shtml</a></td>
</tr>
</tbody>
</table>

### RFCs

<table>
<thead>
<tr>
<th>RFCs</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>No new or modified RFCs are supported by this feature, and support for existing RFCs has not been modified by this feature.</td>
<td>—</td>
</tr>
</tbody>
</table>

### Technical Assistance

<table>
<thead>
<tr>
<th>Description</th>
<th>Link</th>
</tr>
</thead>
<tbody>
<tr>
<td>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.</td>
<td><a href="http://www.cisco.com/cisco/web/support/index.html">http://www.cisco.com/cisco/web/support/index.html</a></td>
</tr>
</tbody>
</table>
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 new and revised tasks you need to implement SNMP on your Cisco IOS XR network.

For detailed conceptual information about SNMP on the Cisco IOS XR software and complete descriptions of the SNMP commands listed in this module, see Related Documents, on page 50. For information on specific MIBs, refer to Cisco ASR 9000 Series Aggregation Services Routers MIB Specifications Guide. To locate documentation for other commands that might appear in the course of performing a configuration task, search online in Cisco ASR 9000 Series Aggregation Services Router Commands Master List.

Table 6: Feature History for Implementing SNMP on Cisco IOS XR Software

<table>
<thead>
<tr>
<th>Release</th>
<th>Modification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Release 3.7.2</td>
<td>This feature was introduced.</td>
</tr>
<tr>
<td>Release 3.9.0</td>
<td>Support was added for 3DES and AES encryption.</td>
</tr>
<tr>
<td></td>
<td>The ability to preserve ENTITY-MIB and CISCO-CLASS-BASED-QOS-MIB data was added.</td>
</tr>
<tr>
<td>Release 4.2.0</td>
<td>Support was added for SNMP over IPv6.</td>
</tr>
</tbody>
</table>

This module contains the following topics:

- Prerequisites for Implementing SNMP, on page 28
- Restrictions for SNMP Use on Cisco IOS XR Software, on page 28
- Information About Implementing SNMP, on page 28
- Session MIB support on subscriber sessions, on page 34
- How to Implement SNMP on Cisco IOS XR Software, on page 35
- Configuration Examples for Implementing SNMP, on page 44
- Additional References, on page 50
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 that a 10 Gigabit interface is greater than this and so if you are trying to display speed information regarding the interface, you might see concatenated results.

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**

![Diagram of communication between SNMP manager and agent]

**Related Topics**

Additional References, on page 50

## SNMP Notifications

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

**Note**


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

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

**Figure 2: Trap Received by the SNMP Manager**

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

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 Table 8: SNMP Security Models and Levels, on page 31 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 SNMPv3.

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.

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

<table>
<thead>
<tr>
<th>Feature</th>
<th>SNMP v1</th>
<th>SNMP v2c</th>
<th>SNMP v3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Get-Bulk Operation</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Inform Operation</td>
<td>No</td>
<td>Yes (No on the Cisco IOS XR software)</td>
<td>Yes (No on the Cisco IOS XR software)</td>
</tr>
<tr>
<td>64 Bit Counter</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Textual Conventions</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Authentication</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Privacy (Encryption)</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Authorization and Access Controls (Views)</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
</tbody>
</table>

### 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>
<thead>
<tr>
<th>Model</th>
<th>Level</th>
<th>Authentication</th>
<th>Encryption</th>
<th>What Happens</th>
</tr>
</thead>
<tbody>
<tr>
<td>v1</td>
<td>noAuthNoPriv</td>
<td>Community string</td>
<td>No</td>
<td>Uses a community string match for authentication.</td>
</tr>
</tbody>
</table>
## 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.

### Configuring Simple Network Management Protocol

#### SNMPv3 Benefits

<table>
<thead>
<tr>
<th>Model</th>
<th>Level</th>
<th>Authentication</th>
<th>Encryption</th>
<th>What Happens</th>
</tr>
</thead>
<tbody>
<tr>
<td>v2c</td>
<td>noAuthNoPriv</td>
<td>Community string</td>
<td>No</td>
<td>Uses a community string match for authentication.</td>
</tr>
<tr>
<td>v3</td>
<td>noAuthNoPriv</td>
<td>Username</td>
<td>No</td>
<td>Uses a username match for authentication.</td>
</tr>
<tr>
<td>v3</td>
<td>authNoPriv</td>
<td>HMAC-MD5 or HMAC-SHA</td>
<td>No</td>
<td>Provides authentication based on the HMAC-MD5 or HMAC-SHA algorithm.</td>
</tr>
<tr>
<td>v3</td>
<td>authPriv</td>
<td>HMAC-MD5 or HMAC-SHA</td>
<td>DES</td>
<td>Provides authentication based on the HMAC-MD5 or HMAC-SHA algorithms. Provides DES 56-bit encryption in addition to authentication based on the CBC DES (DES-56) standard.</td>
</tr>
<tr>
<td>v3</td>
<td>authPriv</td>
<td>HMAC-MD5 or HMAC-SHA</td>
<td>3DES</td>
<td>Provides authentication based on the HMAC-MD5 or HMAC-SHA algorithms. Provides 168-bit 3DES level of encryption.</td>
</tr>
<tr>
<td>v3</td>
<td>authPriv</td>
<td>HMAC-MD5 or HMAC-SHA</td>
<td>AES</td>
<td>Provides authentication based on the HMAC-MD5 or HMAC-SHA algorithms. Provides 128-bit AES level of encryption.</td>
</tr>
</tbody>
</table>

---

3 Hash-Based Message Authentication Code
4 Message Digest 5
5 Secure Hash Algorithm
6 Data Encryption Standard
7 Cipher Block Chaining
8 Triple Data Encryption Standard
9 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 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>
<thead>
<tr>
<th>Security Model</th>
<th>Security Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>SNMPv2c</td>
<td>noAuthNoPriv</td>
</tr>
<tr>
<td>SNMPv3</td>
<td>noAuthNoPriv</td>
</tr>
<tr>
<td>SNMPv3</td>
<td>authNoPriv</td>
</tr>
<tr>
<td>SNMPv3</td>
<td>authPriv</td>
</tr>
</tbody>
</table>

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

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


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

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

*Figure 4: Trap Received by the SNMP Manager*

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

*Figure 5: Trap Not Received by the SNMP Manager*

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

**Session Types**

The supported session types are:

- PPPoE
- IP SUB PKT
- IP SUB DHCP

**How to Implement SNMP on Cisco IOS XR Software**

This section describes how to implement SNMP.

The `snmp-server` commands enable SNMP on Management Ethernet interfaces by default. For information on how to enable SNMP server support on other inband interfaces, see the Implementing Management Plane System Management Configuration Guide for Cisco ASR 9000 Series Routers, IOS XR Release 6.2.x.
Configuring SNMPv3

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

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. `snmp-server view view-name oid-tree {included | excluded}`
3. `snmp-server group name {v1 | v2c | v3 [auth | noauth | priv]} [read view] [write view] [notify view] [access-list-name]`
4. `snmp-server user username groupname {v1 | v2c | v3 [auth {md5 | sha} {clear | encrypted}] auth-password [priv des56 {clear | encrypted} priv-password]} [access-list-name]`
5. `commit`

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td>configure</td>
</tr>
<tr>
<td><strong>Step 2</strong></td>
<td>`snmp-server view view-name oid-tree {included</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>RP/0/RSP0/CPU0:router(config)# snmp-server view view_name 1.3.6.1.2.1.1.5 included</td>
</tr>
<tr>
<td><strong>Step 3</strong></td>
<td>`snmp-server group name {v1</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>RP/0/RSP0/CPU0:router(config)# snmp-server group group_name v3 noauth read view_name1 write view_name2</td>
</tr>
<tr>
<td><strong>Step 4</strong></td>
<td>`snmp-server user username groupname {v1</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>Configures a new user to an SNMP group.</td>
</tr>
<tr>
<td><strong>Purpose</strong></td>
<td>Creates or modifies a view record.</td>
</tr>
<tr>
<td><strong>Purpose</strong></td>
<td>Configures a new SNMP group or a table that maps SNMP users to SNMP views.</td>
</tr>
</tbody>
</table>


### Purpose

<table>
<thead>
<tr>
<th>Command or Action</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>auth-password</code></td>
</tr>
<tr>
<td><code>priv-password</code></td>
</tr>
<tr>
<td><code>access-list-name</code></td>
</tr>
</tbody>
</table>

#### Example:

```
RP/0/RSP0/CPU0:router(config)# snmp-server user noauthuser group_name v3
```

### Note

Only one remote host can be assigned to the same username for SNMP version 3. If you configure the same username with different remote hosts, only the last username and remote host combination will be accepted and will be seen in the `show running` configuration. In the case of multiple SNMP managers, multiple unique usernames are required.

### Step 5

Commit

---

## Configuring SNMP Trap Notifications

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

You can omit Step 3, on page 36 if you have already completed the steps documented under the Configuring SNMPv3, on page 36 task.

### SUMMARY STEPS

1. `configure`
2. `snmp-server group name {v1 | v2c | 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 | encrypted} priv-password]} [access-list-name]
4. `snmp-server host address [traps] [version {1 | 2c | 3 {auth | noauth | priv}]} community-string [udp-port port] [notification-type]
5. `snmp-server traps [notification-type]
6. `commit`
7. (Optional) `show snmp host`

### DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>configure</code></td>
</tr>
</tbody>
</table>

#### Step 2

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

**Example:**

```
RP/0/RSP0/CPU0:router(config)# snmp-server group group_name v3 noauth read view_name1 write view_name2
```
### Configuring Simple Network Management Protocol

#### 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`
Defining Simple Network Management Protocol

4. (Optional) `snmp-server chassis-id serial-number`
5. `commit`

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1 configure</td>
<td></td>
</tr>
<tr>
<td>Step 2 (Optional) <code>snmp-server contact system-contact-string</code></td>
<td>Sets the system contact string.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>RP/0/RSP0/CPU0:router(config)# snmp-server contact</td>
<td>Dial System Operator at beeper # 27345</td>
</tr>
<tr>
<td>Step 3 (Optional) <code>snmp-server location system-location</code></td>
<td>Sets the system location string.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>RP/0/RSP0/CPU0:router(config)# snmp-server location</td>
<td>Building 3/Room 214</td>
</tr>
<tr>
<td>Step 4 (Optional) <code>snmp-server chassis-id serial-number</code></td>
<td>Sets the system serial number.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>RP/0/RSP0/CPU0:router(config)# snmp-server chassis-id</td>
<td>1234456</td>
</tr>
<tr>
<td>Step 5 commit</td>
<td></td>
</tr>
</tbody>
</table>

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. `commit`

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1 configure</td>
<td></td>
</tr>
</tbody>
</table>
### Purpose

#### Command or Action

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

**Example:**

RP/0/RSP0/CPU0:router(config)# snmp-server packetsize 1024

**Step 3**
- **commit**

### 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. **commit**

### DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td><strong>configure</strong></td>
</tr>
</tbody>
</table>
| **Step 2** | **(Optional)** *snmp-server trap-source type interface-path-id*

**Example:**

RP/0/RSP0/CPU0:router(config)# snmp-server trap-source POS 0/1/0

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

**Example:**

RP/0/RSP0/CPU0:router(config)# snmp-server queue-length 20

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

**Example:**

RP/0/RSP0/CPU0:router(config)# snmp-server trap-timeout 10

Defines how often to resend notifications on the retransmission queue.
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. commit

DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> configure</td>
<td>Configures an IP precedence or IP DSCP value for SNMP traffic.</td>
</tr>
<tr>
<td><strong>Step 2</strong> Use one of the following commands:</td>
<td></td>
</tr>
<tr>
<td>• <code>snmp-server ipv4 precedence value</code></td>
<td></td>
</tr>
<tr>
<td>• <code>snmp-server ipv4 dscp value</code></td>
<td></td>
</tr>
<tr>
<td>Example:</td>
<td><code>RP/0/RSP0/CPU0:router(config)# snmp-server dscp 24</code></td>
</tr>
<tr>
<td><strong>Step 3</strong> commit</td>
<td></td>
</tr>
</tbody>
</table>

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**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong>&lt;br&gt;(Optional) <code>snmp-server entityindex persist</code>&lt;br&gt;Example:&lt;br&gt;<code>RP/0/RSP0/CPU0:router(config)# snmp-server entityindex persist</code></td>
<td>Enables the persistent storage of ENTITY-MIB data.</td>
</tr>
<tr>
<td><strong>Step 2</strong>&lt;br&gt;(Optional) <code>snmp-server mibs cbqosmib persist</code>&lt;br&gt;Example:&lt;br&gt;<code>RP/0/RSP0/CPU0:router(config)# snmp-server mibs cbqosmib persist</code></td>
<td>Enables persistent storage of the CISCO-CLASS-BASED-QOS-MIB data.</td>
</tr>
<tr>
<td><strong>Step 3</strong>&lt;br&gt;(Optional) <code>snmp-server cbqosmib cache refresh time time</code>&lt;br&gt;Example:&lt;br&gt;<code>RP/0/RSP0/CPU0:router(config)# snmp-server mibs cbqosmib cache refresh time 45</code></td>
<td>Enables QoS MIB caching with a specified cache refresh time.</td>
</tr>
<tr>
<td><strong>Step 4</strong>&lt;br&gt;(Optional) <code>snmp-server cbqosmib cache service-policy count count</code>&lt;br&gt;Example:&lt;br&gt;<code>RP/0/RSP0/CPU0:router(config)# snmp-server mibs cbqosmib cache service-policy count 50</code></td>
<td>Enables QoS MIB caching with a limited number of service policies to cache.</td>
</tr>
<tr>
<td><strong>Step 5</strong>&lt;br&gt;<code>snmp-server ifindex persist</code>&lt;br&gt;Example:&lt;br&gt;<code>RP/0/RSP0/CPU0:router(config)# snmp-server ifindex persist</code></td>
<td>Enables ifIndex persistence globally on all Simple Network Management Protocol (SNMP) interfaces.</td>
</tr>
</tbody>
</table>
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. commit
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

<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1</td>
<td>configure</td>
<td>Enters snmp-server interface mode for the interfaces identified by the regular expression.</td>
</tr>
<tr>
<td>Step 2</td>
<td>snmp-server interface subset subset-number regular-expression expression</td>
<td>Enter snmp-server interface mode for the interfaces identified by the regular expression.</td>
</tr>
</tbody>
</table>

Example:
RP/0/RSP0/CPU0:router(config)# snmp-server interface subset 10 regular-expression "^Gig[a-zA-Z]+[0-9/]+\." RP/0/RSP0/CPU0:router(config-snmp-if-subset)#

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

The expression argument must be entered surrounded by double quotes.

Refer to the Understanding Regular Expressions, Special Characters, and Patterns module in Cisco ASR 9000 Series Aggregation Services Router Getting Started Guide for more information regarding regular expressions.

Step 3 | notification linkupdown disable | Disables linkUp and linkDown traps for all interfaces being configured. To enable previously disabled interfaces, use the no form of this command. |

Example:
RP/0/RSP0/CPU0:router(config-snmp-if-subset)# notification linkupdown disable

Step 4 | commit | |

Step 5 | (Optional) show snmp interface notification subset subset-number | Displays the linkUp and linkDown notification status for all interfaces identified by the subset priority. |

Example:
### Command or Action

**RP/0/RSP0/CPU0:router# show snmp interface notification subset 10**

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

### Step 6

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

**Example:**

**RP/0/RSP0/CPU0:router# show snmp interface notification regular-expression "^Gig[a-zA-Z]+[0-9/]\."**

### Step 7

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

**Example:**

**RP/0/RSP0/CPU0:router# show snmp interface notification tengige 0/4/0/3.10**

### Configuration Examples for Implementing SNMP

#### Configuring SNMPv3: Examples

**Setting an Engine ID**

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

```plaintext
snmp-server engineID local 00:00:00:09:00:00: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:

```plaintext
config
  show snmp engineid

SNMP engineID 00000009000000a1ffffffff
```
Creating a View

There are two ways to create a view:

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

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

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

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

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

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

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

Verifying Configured Views

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

```
RP/0/RSP0/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/RSP0/CPU0:router(config)# 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)`:
Verifying Groups

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

```
RP/0/RSP0/CPU0:router# show snmp group

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

Creating and Verifying Users

Given the following SNMPv3 view and SNMPv3 group configuration:

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

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

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

Note

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

Only one remote host can be assigned to the same username for SNMP version 3. If you configure the same username with different remote hosts, only the last username and remote host combination will be accepted and will be seen in the show running configuration. In the case of multiple SNMP managers, multiple unique usernames are required.

This example shows the same username case which only the last configuration will be accepted:

```
RP/0/RSP0/CPU0:router# show run snmp-server user

  snmp-server user username nervectrgrp remote 10.69.236.146 udp-port 162 v3 auth sha
  priv aes 128 <password>
  snmp-server user username nervectrgrp remote 10.214.127.2 udp-port 162 v3 auth sha <password>
  priv aes 128 <password>
  snmp-server user username nervectrgrp remote 10.69.236.147 udp-port 162 v3 auth sha <password>
  priv aes 128 <password>
```
encrypted <password> priv aes 128 encrypted <password>

This example shows all 3 hosts for username1, username2, and username3 will be accepted.

snmp-server user username1 nervectrgrp remote 10.69.236.146 udp-port 162 v3 auth sha<br>encrypted <password> priv aes 128 <password>

snmp-server user username2 nervectrgrp remote 10.214.127.2 udp-port 162 v3 auth sha<br>encrypted <password> priv aes 128 <password>

snmp-server user username3 nervectrgrp remote 10.69.236.147 udp-port 162 v3 auth sha<br>encrypted <password> priv aes 128 <password>

RP/0/RSP0/CPU0:router# show run snmp-server user

snmp-server user batmanusr1 nervectrgrp remote 10.69.236.146 udp-port 162 v3 auth sha<br>encrypted <password> priv aes 128 encrypted <password>

snmp-server user batmanusr2 nervectrgrp remote 10.214.127.2 udp-port 162 v3 auth sha<br>encrypted <password> priv aes 128 encrypted <password>

snmp-server user batmanusr3 nervectrgrp remote 10.69.236.147 udp-port 162 v3 auth sha<br>encrypted <password> priv aes 128 encrypted <password>

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

RP/0/RSP0/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/RSP0/CPU0:router(config)# snmp-server user authuser group_name v3 auth md5 clear auth_passwd
```
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 the 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/RSP0/CPU0:router# show snmp user
```

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

Given the following SNMPv3 view and SNMPv3 group configuration:

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

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

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

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/RSP0/CPU0:router# show snmp user
```

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

### 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.
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 userv2c 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 user userv2c groupv2c v2c
snmp-server user userV3auth groupV3auth v3 auth md5 encrypted 140F0A13
snmp-server user userV3priv groupV3priv v3 auth md5 encrypted 021E1C43 priv des56 encrypted 1110001C
snmp-server user userV3noauth groupV3noauth v3 LROwner
snmp-server view view_name 1.3 included
snmp-server community public RW
snmp-server group groupv2c v2c read view_name
snmp-server group groupV3auth v3 auth read view_name
snmp-server group groupV3priv v3 priv read view_name
snmp-server group groupV3noauth v3 noauth read view_name
!
```

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

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

```
config
  show snmp host
  Notification host: 10.50.32.170 udp-port: 2345 type: trap
  user: userV3auth security model: v3 auth
  Notification host: 10.50.32.170 udp-port: 2345 type: trap
  user: userV3noauth security model: v3 noauth
  Notification host: 10.50.32.170 udp-port: 2345 type: trap
  user: userV3priv security model: v3 priv
  Notification host: 10.50.32.170 udp-port: 2345 type: trap
  user: userv2c security model: v2c
```

**Setting an IP Precedence Value for SNMP Traffic: Example**

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

```
configure
```
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

Additional References

The following sections provide references related to Implementing SNMP on Cisco IOS XR software.

**Related Documents**

<table>
<thead>
<tr>
<th>Related Topic</th>
<th>Document Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cisco IOS XR SNMP commands</td>
<td>SNMP Server Commands on the Cisco ASR 9000 Series Router module of System Management Command Reference for Cisco ASR 9000 Series Routers</td>
</tr>
<tr>
<td>MIB information</td>
<td>Cisco ASR 9000 Series Aggregation Services Routers MIB Specifications Guide</td>
</tr>
<tr>
<td>Cisco IOS XR commands</td>
<td>Cisco ASR 9000 Series Aggregation Services Router Commands Master List</td>
</tr>
<tr>
<td>Getting started with Cisco IOS XR software</td>
<td>Cisco ASR 9000 Series Aggregation Services Router Getting Started Guide</td>
</tr>
<tr>
<td>Information about user groups and task IDs</td>
<td>Configuring AAA Services on the Cisco ASR 9000 Series Router module of System Security Configuration Guide for Cisco ASR 9000 Series Routers</td>
</tr>
<tr>
<td>Cisco IOS XR Quality of Service</td>
<td>Modular QoS Configuration Guide for Cisco ASR 9000 Series Routers</td>
</tr>
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</table>
Standards

<table>
<thead>
<tr>
<th>Standards</th>
<th>Title</th>
</tr>
</thead>
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<tr>
<td>No new or modified standards are supported by this feature, and support for existing standards has not been modified by this feature.</td>
<td>—</td>
</tr>
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</table>

MIBs

<table>
<thead>
<tr>
<th>MIBs</th>
<th>MIBs Link</th>
</tr>
</thead>
<tbody>
<tr>
<td>—</td>
<td>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: <a href="http://cisco.com/public/sw-center/netmgmt/cmtk/mibs.shtml">http://cisco.com/public/sw-center/netmgmt/cmtk/mibs.shtml</a></td>
</tr>
</tbody>
</table>

RFCs

<table>
<thead>
<tr>
<th>RFCs</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>RFC 3411</td>
<td><em>An Architecture for Describing Simple Network Management Protocol (SNMP) Management Frameworks</em></td>
</tr>
<tr>
<td>RFC 3412</td>
<td><em>Message Processing and Dispatching for the Simple Network Management Protocol (SNMP)</em></td>
</tr>
<tr>
<td>RFC 3413</td>
<td><em>Simple Network Management Protocol (SNMP) Applications</em></td>
</tr>
<tr>
<td>RFC 3414</td>
<td><em>User-based Security Model (USM) for version 3 of the Simple Network Management Protocol (SNMPv3)</em></td>
</tr>
<tr>
<td>RFC 3415</td>
<td><em>View-based Access Control Model (VACM) for the Simple Network Management Protocol (SNMP)</em></td>
</tr>
<tr>
<td>RFC 3417</td>
<td><em>Transport Mappings for the Simple Network Management Protocol (SNMP)</em></td>
</tr>
<tr>
<td>RFC 3418</td>
<td><em>Management Information Base (MIB) for the Simple Network Management Protocol (SNMP)</em></td>
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Technical Assistance

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<thead>
<tr>
<th>Description</th>
<th>Link</th>
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<tbody>
<tr>
<td>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.</td>
<td><a href="http://www.cisco.com/cisco/web/support/index.html">http://www.cisco.com/cisco/web/support/index.html</a></td>
</tr>
</tbody>
</table>
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 Related Documents, on page 61. To locate documentation for other commands that might appear in the course of performing a configuration task, search online in Cisco ASR 9000 Series Aggregation Services Router Commands Master List.

Table 10: Feature History for Implementing Object Tracking

<table>
<thead>
<tr>
<th>Release</th>
<th>Modification</th>
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</thead>
<tbody>
<tr>
<td>Release 4.0.0</td>
<td>This feature was introduced.</td>
</tr>
<tr>
<td>Release 4.2.1</td>
<td>The ability to create a tracked list based on a threshold percentage or weight was added.</td>
</tr>
</tbody>
</table>

This module contains the following topics:

- Prerequisites for Implementing Object Tracking, on page 53
- Information About Object Tracking, on page 53
- How to Implement Object Tracking, on page 54
- Configuration Examples for Configuring Object Tracking, on page 60
- Additional References, on page 60

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.

Information About Object Tracking

Object tracking is a mechanism for tracking an object to take any client action on another object as configured by the client. The object on which the client action is performed may not have any relationship to the tracked objects. The client actions are performed based on changes to the properties of the object being tracked.

You can identify each tracked object by a unique name that is specified by the track command in the configuration mode.
The tracking process periodically polls the tracked object and reports any changes to its state. The state of the tracked objects can be up or down. The polling occurs either immediately or after a delay of a configured period.

You can also track multiple objects by a list. You can use 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 that is defined within a subset must be in an "up" state. This condition enables the tracked object to be in the "up" state.
- **Boolean OR function**—When the tracked list has been assigned a Boolean OR function, at least one object that is defined within a subset must also be in an "up" state. This condition enables the tracked object to 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**

<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1</td>
<td>configure</td>
<td></td>
</tr>
<tr>
<td>Step 2</td>
<td>track track-name</td>
<td>Enters track configuration mode.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>RP/0/RSP0/CPU0:router(config)# track track1</td>
<td>• track-name—Specifies a name for the object to be tracked.</td>
</tr>
</tbody>
</table>
### Configuring Object Tracking

#### Tracking the Line Protocol State of an Interface

<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
</table>
| **Step 3** | *type* line-protocol state  
**Example:**  
RP/0/RSP0/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/RSP0/CPU0:router(config-track-line-prot)# interface atm 0/2/0/0.1 | Specifies the interface to track the protocol state.  
- *type*—Specifies the interface type. For more information, use the question mark (?) online help function.  
- *interface-path-id*—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/RSP0/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/RSP0/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:  
- *end*  
- *commit*  
**Example:**  
RP/0/RSP0/CPU0:router(config-track)# end  
or  
RP/0/RSP0/CPU0:router(config-track)# commit | Saves configuration changes.  
- When you issue the *end* command, the system prompts you to commit changes:  
Uncommitted changes found, commit them before exiting(yes/no/cancel)? [cancel]:  
- Entering *yes* saves configuration changes to the running configuration file, exits the configuration session, and returns the router to EXEC mode.  
- Entering *no* exits the configuration session and returns the router to EXEC mode without committing the configuration changes.  
- Entering *cancel* leaves the router in the current configuration session without exiting or committing the configuration changes. |
## Purpose

- 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. `commit`

### DETAILED STEPS

<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1</td>
<td><code>configure</code></td>
<td>Enters track configuration mode.</td>
</tr>
<tr>
<td>Step 2</td>
<td><code>track track-name</code></td>
<td>Configures the routing process to notify the tracking process when the state of the route changes due to a routing update.</td>
</tr>
<tr>
<td>Example:</td>
<td><code>track track1</code></td>
<td><code>track-name</code>—Specifies a name for the object to be tracked.</td>
</tr>
<tr>
<td>Step 3</td>
<td><code>type route reachability</code></td>
<td>Configures the type of IP route to be tracked, which can consist of either of the following, depending on your router type:</td>
</tr>
<tr>
<td>Example:</td>
<td><code>type route reachability vrf internet</code></td>
<td><code>vrf-table-name</code>—A VRF table name.</td>
</tr>
<tr>
<td>Step 4</td>
<td>Use one of the following commands:</td>
<td></td>
</tr>
<tr>
<td>Example:</td>
<td></td>
<td><code>IP-prefix/mask</code>—An IP prefix consisting of the network and subnet mask (for example, 10.56.8.10/16).</td>
</tr>
</tbody>
</table>
### Purpose

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>RP/0/RSP0/CPU0:router(config-track-route)# vrf vrf-table-4</td>
<td></td>
</tr>
<tr>
<td>or</td>
<td></td>
</tr>
<tr>
<td>RP/0/RSP0/CPU0:router(config-track-route)# route ipv4 10.56.8.10/16</td>
<td></td>
</tr>
</tbody>
</table>

#### Step 5

**exit**

**Example:**

RP/0/RSP0/CPU0:router(config-track-line-prot)# exit

#### Step 6

(Optional) **delay** \( \{ \text{up seconds} | \text{down seconds} \} \)

**Example:**

RP/0/RSP0/CPU0:router(config-track)# delay up 10

#### Step 7

**commit**

---

**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
### BUILDING A TRACK BASED ON A LIST OF OBJECTS

#### DETAILED STEPS

<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>configure</td>
<td>Enters track configuration mode.</td>
</tr>
<tr>
<td>2</td>
<td>track track-name</td>
<td>enter track configuration mode.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td>• track-name—Specifies a name for the object to be tracked.</td>
</tr>
<tr>
<td></td>
<td>RP/0/RSP0/CPU0:router(config)#</td>
<td></td>
</tr>
<tr>
<td></td>
<td>track track1</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>type list boolean { and</td>
<td>or }</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td>• boolean—Specifies that the state of the tracked list is based on a Boolean calculation.</td>
</tr>
<tr>
<td></td>
<td>RP/0/RSP0/CPU0:router(config-track-list)# type list</td>
<td>• 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.</td>
</tr>
<tr>
<td></td>
<td>boolean and</td>
<td>• 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.</td>
</tr>
<tr>
<td>4</td>
<td>object object-name [ not ]</td>
<td>Specifies the object to be tracked by the list</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td>• object-name—Name of the object to track.</td>
</tr>
<tr>
<td></td>
<td>RP/0/RSP0/CPU0:router(config-track-list)# object</td>
<td>• not—Negates the state of the object.</td>
</tr>
<tr>
<td></td>
<td>3 not</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>exit</td>
<td>Exits the track line protocol configuration mode.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>RP/0/RSP0/CPU0:router(config-track-line-prot)# exit</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>(Optional) delay { up seconds</td>
<td>down seconds}</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>RP/0/RSP0/CPU0:router(config-track)# delay up 10</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Use one of the following commands:</td>
<td>Saves configuration changes.</td>
</tr>
<tr>
<td></td>
<td>• end</td>
<td>• When you issue the end command, the system prompts you to commit changes:</td>
</tr>
<tr>
<td></td>
<td>• commit</td>
<td>Uncommitted changes found, commit them before exiting(yes/no/cancel)?</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td>[cancel]:</td>
</tr>
<tr>
<td></td>
<td>RP/0/RSP0/CPU0:router(config-track)# end</td>
<td></td>
</tr>
<tr>
<td></td>
<td>or</td>
<td></td>
</tr>
</tbody>
</table>
### Purpose

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
</table>
| RP/0/RSP0/CPU0:router(config-track)# commit | • Entering **yes** saves configuration changes to the running configuration file, exits the configuration session, and returns the router to EXEC mode.  
  • Entering **no** exits the configuration session and returns the router to EXEC mode without committing the configuration changes.  
  • Entering **cancel** leaves the router in the current configuration session without exiting or committing the configuration changes.  
  • Use the **commit** command to save the configuration changes to the running configuration file and remain within the configuration session. |

---

### 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. **commit**

#### DETAILED STEPS

<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td><strong>configure</strong></td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td>Example:</td>
<td>RP/0/RSP0/CPU0:router(config-track)# configure</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td><strong>track</strong> <em>track-name</em></td>
<td>Enters track configuration mode.</td>
</tr>
<tr>
<td>Example:</td>
<td>RP/0/RSP0/CPU0:router(config)# track t1</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td><strong>type rtr</strong> <em>ipsla-no reachability</em></td>
<td>Specifies the IP SLA operation ID to be tracked for reachability. Values for the <em>ipsla-no</em> can range from 1 to 2048.</td>
</tr>
<tr>
<td>Example:</td>
<td>RP/0/RSP0/CPU0:router(config-track)# type rtr 100 reachability</td>
<td></td>
</tr>
</tbody>
</table>
Configuring IPSLA Tracking: Example

This example shows the configuration of IPSLA tracking:

RP/0/RSP0/CPU0:router(config)# track track1
RP/0/RSP0/CPU0:router(config-track)# type rtr 1 reachability
RP/0/RSP0/CPU0:router(config-track)# delay up 5
RP/0/RSP0/CPU0:router(config-track)# delay down 10

Configuration Examples for Configuring Object Tracking

Configuring IPSLA Tracking: Example

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

ACL configuration:

RP/0/RSP0/CPU0:router(config)# ipv4 access-list abf-track
RP/0/RSP0/CPU0:router(config-ipv4-acl)# 10 permit any any nexthop track track1 1.2.3.4

Object tracking configuration:

RP/0/RSP0/CPU0:router(config)# track track1
RP/0/RSP0/CPU0:router(config-track)# type rtr 1 reachability
RP/0/RSP0/CPU0:router(config-track)# delay up 5
RP/0/RSP0/CPU0:router(config-track)# delay down 10

IPSLA configuration:

RP/0/RSP0/CPU0:router(config)# ipsla
RP/0/RSP0/CPU0:router(config-ipsla)# operation 1
RP/0/RSP0/CPU0:router(config-ipsla-op)# type icmp echo
RP/0/RSP0/CPU0:router(config-ipsla-icmp-echo)# source address 2.3.4.5
RP/0/RSP0/CPU0:router(config-ipsla-icmp-echo)# destination address 1.2.3.4
RP/0/RSP0/CPU0:router(config-ipsla-icmp-echo)# frequency 60
RP/0/RSP0/CPU0:router(config-ipsla-icmp-echo)# exit
RP/0/RSP0/CPU0:router(config-ipsla-op)# exit
RP/0/RSP0/CPU0:router(config-ipsla)# schedule operation 1
RP/0/RSP0/CPU0:router(config-ipsla-sched)# start-time now
RP/0/RSP0/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

<table>
<thead>
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<th>Related Topic</th>
<th>Document Title</th>
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<tr>
<td>IP SLA configuration information</td>
<td>Implementing IP Service Level Agreements on the Cisco ASR 9000 Series Router module in System Monitoring Configuration Guide for Cisco ASR 9000 Series Routers</td>
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<td>Object tracking commands</td>
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## Standards

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## RFCs

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<tr>
<td>RFC 2401</td>
<td>Security Architecture for the Internet Protocol</td>
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</tbody>
</table>

## Technical Assistance

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</tr>
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<td><a href="http://www.cisco.com/cisco/web/support/index.html">http://www.cisco.com/cisco/web/support/index.html</a></td>
</tr>
</tbody>
</table>
Additional References
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.

This module describes the new and revised tasks you need to implement CDP on your Cisco IOS XR network.

For more information about CDP on the Cisco IOS XR software and complete descriptions of the CDP commands listed in this module, refer to Related Documents, on page 71. To locate documentation for other commands that might appear in the course of running a configuration task, search online in Cisco ASR 9000 Series Aggregation Services Router Commands Master List.

Table 11: Feature History for Implementing CDP on Cisco IOS XR Software

<table>
<thead>
<tr>
<th>Release</th>
<th>Modification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Release 3.7.2</td>
<td>This feature was introduced.</td>
</tr>
<tr>
<td>Release 3.9.0</td>
<td>No modification.</td>
</tr>
</tbody>
</table>

This module contains the following topics:

- Prerequisites for Implementing CDP, on page 63
- Information About Implementing CDP, on page 64
- How to Implement CDP on Cisco IOS XR Software, on page 65
- Configuration Examples for Implementing CDP, on page 70
- Additional References, on page 70

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.
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. Table 12: Type-Length-Value Definitions for CDPv2, on page 64 summarizes the TLV definitions for CDP advertisements.

**Table 12: Type-Length-Value Definitions for CDPv2**

<table>
<thead>
<tr>
<th>TLV</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Device-ID TLV</td>
<td>Identifies the device name in the form of a character string.</td>
</tr>
<tr>
<td>Address TLV</td>
<td>Contains a list of network addresses of both receiving and sending devices.</td>
</tr>
<tr>
<td>Port-ID TLV</td>
<td>Identifies the port on which the CDP packet is sent.</td>
</tr>
<tr>
<td>Capabilities TLV</td>
<td>Describes the functional capability for the device in the form of a device type; for example, a switch.</td>
</tr>
<tr>
<td>Version TLV</td>
<td>Contains information about the software release version on which the device is running.</td>
</tr>
<tr>
<td>Platform TLV</td>
<td>Describes the hardware platform name of the device, for example, Cisco 4500.</td>
</tr>
</tbody>
</table>
### TLV Definition

<table>
<thead>
<tr>
<th>TLV</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>VTP Management Domain TLV</td>
<td>Advertises the system’s configured VTP management domain name-string. Used by network operators to verify VTP domain configuration in adjacent network nodes.</td>
</tr>
<tr>
<td>Native VLAN TLV</td>
<td>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.</td>
</tr>
<tr>
<td>Full/Half Duplex TLV</td>
<td>Indicates status (duplex configuration) of CDP broadcast interface. Used by network operators to diagnose connectivity problems between adjacent network elements.</td>
</tr>
</tbody>
</table>

### 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. `commit`

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td></td>
</tr>
<tr>
<td><code>configure</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 2</strong></td>
<td></td>
</tr>
<tr>
<td><code>cdp</code></td>
<td>Enables CDP globally.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td><code>RP/0/RSP0/CPU0:router(config)# cdp</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong></td>
<td></td>
</tr>
<tr>
<td><code>interface type interface-path-id</code></td>
<td>Enters interface configuration mode.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
</tbody>
</table>
| `RP/0/RSP0/CPU0:router(config)# interface pos 0/0/0/1` | }
### Purpose

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 4 cdp</td>
<td>Enables CDP on an interface.</td>
</tr>
</tbody>
</table>

#### Example:

```
RP/0/RSP0/CPU0:router(config-if)# cdp
```

<table>
<thead>
<tr>
<th>Step 5 commit</th>
<th></th>
</tr>
</thead>
</table>

### 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. `commit`
6. (Optional) `show cdp`

### DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1 configure</td>
<td></td>
</tr>
</tbody>
</table>

#### Step 2 cdp advertise v1

Example:

```
RP/0/RSP0/CPU0:router(config)# cdp advertise v1
```

#### Step 3 cdp holdtime seconds

Example:

```
RP/0/RSP0/CPU0:router(config)# cdp holdtime 30
```

### Purpose

- Configures CDP to use only version 1 (CDPv1) in communicating with neighboring devices.
  - By default, when CDP is enabled, the router sends CDPv2 packets. CDP also sends and receives CDPv1 packets if the device with which CDP is interacting does not process CDPv2 packets.
  - In this example, the router is configured to send and receive only CDPv1 packets.

- Specifies the amount of time that the receiving networking device will hold a CDP packet sent from the router before discarding it.
  - By default, when CDP is enabled, the receiving networking device holds a CDP packet for 180 seconds before discarding it.
### Purpose

Command or Action | Purpose
--- | ---

### Command or Action

**cdp timer seconds**

**Step 4**

Example:

```
RP/0/RSP0/CPU0:router(config)# cdp timer 20
```

Specifies the frequency at which CDP update packets are sent.

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

**Note**

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

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

**Step 5**

commit

**Step 6**

(Optional) **show cdp**

Example:

```
RP/0/RSP0/CPU0:router# show cdp
```

Displays global CDP information.

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

### Monitoring CDP

This task shows how to monitor CDP.

**Note**

The commands can be entered in any order.

**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**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
</table>

**Step 1**

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

Example:
<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>RP/0/RSP0/CPU0:router# \show cdp entry *</td>
<td>Displays information about the interfaces on which CDP is enabled.</td>
</tr>
</tbody>
</table>

**Step 2**

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

Example:

RP/0/RSP0/CPU0:router# show cdp interface pos 0/0/0/1

**Step 3**

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

Example:

RP/0/RSP0/CPU0:router# show cdp neighbors

**Step 4**

show cdp traffic [location node-id]

Example:

RP/0/RSP0/CPU0:router# show cdp traffic

### Examples

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

```
RP/0/RSP0/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
router1 Mg0/0/CPU0/0/0 177 T S WS-C2924M Fa0/12
router2 PO0/4/0/0 157 R 12008/GRP Po0/4/0/1
```

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/RSP0/CPU0:router# show cdp neighbors POS 0/4/0/0 detail

-------------------------
Device ID: uut-user
SysName : uut-user
Entry address(es):
  IPv4 address: 1.1.1.1
  IPv4 address: 1.1.1.1
  IPv6 address: 2::2
Platform: cisco 12008/GRP, Capabilities: Router
Interface: POS0/4/0/3
Port ID (outgoing port): POS0/2/0/3
Holdtime : 177 sec
```

Version :
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/RSP0/CPU0:router# show cdp entry router2

advertisement version: 2

-------------------------
Device ID: router2
SysName : router2
Entry address(es):
Platform: cisco 12008/GRP, Capabilities: Router
Interface: POS0/4/0/0
Port ID (outgoing port): POS0/4/0/1
Holdtime : 145 sec

Version :
Cisco IOS XR Software, Version 0.48.0[Default]
Copyright (c) 2004 by cisco Systems, Inc.

advertisement version: 2

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/RSP0/CPU0:router# show cdp interface pos 0/4/0/0

POS0/4/0/0 is Up
Encapsulation HDLC
Sending CDP packets every 60 seconds
Holdtime is 180 seconds

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

RP/0/RSP0/CPU0:router# show cdp traffic

CDP counters :
Packets output: 194, Input: 99
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: 194, Input: 99
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/RSP0/CPU0:router# show cdp traffic location 0/4/cpu0

CDP counters :
Packets output: 16, Input: 13
Configuration Examples for Implementing CDP

Enabling CDP: Example
The following example shows how to configure CDP globally and then enable CDP on Packet over SONET/SDH (POS) interface 0/3/0/0:

```conf
cdp
interface POS0/3/0/0
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:

```conf
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/RSP0/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
```

Additional References
The following sections provide references related to implementing CDP on Cisco IOS XR software.
Related Documents

<table>
<thead>
<tr>
<th>Related Topic</th>
<th>Document Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cisco IOS XR CDP commands</td>
<td>CDP Commands on Cisco IOS XR Software module of System Management Command Reference for Cisco ASR 9000 Series Routers</td>
</tr>
<tr>
<td>Cisco IOS XR commands</td>
<td>Cisco ASR 9000 Series Aggregation Services Router Commands Master List</td>
</tr>
<tr>
<td>Getting started with Cisco IOS XR Software</td>
<td>Cisco ASR 9000 Series Aggregation Services Router Getting Started Guide</td>
</tr>
<tr>
<td>Information about user groups and task IDs</td>
<td>Configuring AAA Services on Cisco IOS XR Software module of System Security Configuration Guide for Cisco ASR 9000 Series Routers</td>
</tr>
</tbody>
</table>

Standards

<table>
<thead>
<tr>
<th>Standards</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>No new or modified standards are supported by this feature, and support for existing standards has not been modified by this feature.</td>
<td></td>
</tr>
</tbody>
</table>

MIBs

<table>
<thead>
<tr>
<th>MIBs</th>
<th>MIBs Link</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>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: <a href="http://cisco.com/public/sw-center/netmgmt/cmtk/mibs.shtml">http://cisco.com/public/sw-center/netmgmt/cmtk/mibs.shtml</a></td>
</tr>
</tbody>
</table>

RFCs

<table>
<thead>
<tr>
<th>RFCs</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No new or modified RFCs are supported by this feature, and support for existing RFCs has not been modified by this feature.</td>
</tr>
</tbody>
</table>

Technical Assistance

<table>
<thead>
<tr>
<th>Description</th>
<th>Link</th>
</tr>
</thead>
<tbody>
<tr>
<td>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.</td>
<td><a href="http://www.cisco.com/cisco/web/support/index.html">http://www.cisco.com/cisco/web/support/index.html</a></td>
</tr>
</tbody>
</table>
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.

Table 13: Feature History for Periodic MIB Data Collection and Transfer

<table>
<thead>
<tr>
<th>Release</th>
<th>Modification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Release 4.2.0</td>
<td>The periodic MIB data collection and transfer feature was introduced and supported the IF-MIB only.</td>
</tr>
<tr>
<td>Release 4.2.1</td>
<td>Additional MIBs were supported.</td>
</tr>
</tbody>
</table>

This module contains the following topics:

- Prerequisites for Periodic MIB Data Collection and Transfer, on page 73
- Information About Periodic MIB Data Collection and Transfer, on page 74
- 4arg, on page 75
- How to Configure Periodic MIB Data Collection and Transfer, on page 75
- Periodic MIB Data Collection and Transfer: Example, on page 82

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.

4arg

4arg is Cisco’s implementation of Object Size Checking (OSC). OSC is a useful static analysis utility and a critical runtime defense for the detection and prevention of buffer overflows. 4arg captures buffer overflows (at runtime) that are otherwise undetected by code analysis tools and human review. 4arg also carries a reporting and logging component.

4arg refers to a theoretical fourth argument to a string copy function representing the destination buffer size.

4arg Messages: Example

An example of a 4arg message:

```
RP/0/RSP0/CPU0:router:Dec 1 12:00:00.802 : foo[123]:
%OS-DATACORRUPTION-1-DATAINCONSISTENCY : copy error : pkg/bin/foo :
(PID=12345) : -Traceback= 4bd43404 4bac7e04 4000c100
```

If you witness a traceback, please report the incident to Cisco TAC as soon as possible. Include the log message exactly as printed in the console.

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.
Configuring Periodic MIB Data Collection and Transfer

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 object-list list-name
3. add {oid | object-name}
4. commit

### DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> configure</td>
<td></td>
</tr>
<tr>
<td><strong>Step 2</strong> snmp-server mib bulkstat object-list list-name</td>
<td>Defines an SNMP bulk statistics object list and enters bulk statistics object list configuration mode. Example: snmp-server mib bulkstat object-list ifMib</td>
</tr>
<tr>
<td><strong>Step 3</strong> add {oid</td>
<td>object-name}</td>
</tr>
<tr>
<td><strong>Step 4</strong> commit</td>
<td></td>
</tr>
</tbody>
</table>

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.

### What to do next

Configure a bulk statistics schema.
### DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> configure</td>
<td>Names the bulk statistics schema and enters bulk statistics schema mode.</td>
</tr>
<tr>
<td><strong>Step 2</strong> <code>snmp-server mib bulkstat schema schema-name</code></td>
<td>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.</td>
</tr>
<tr>
<td><strong>Example:</strong> RP/0/RSP0/CPU0:router(config)# snmp-server mib bulkstat schema intE0 RP/0/RSP0/CPU0:router(config-bulk-sc)#</td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong> <code>object-list list-name</code></td>
<td>Specifies the instance information for objects in this schema:</td>
</tr>
<tr>
<td><strong>Example:</strong> RP/0/RSP0/CPU0:router(config-bulk-sc)# object-list ifMib</td>
<td>- The <code>instance exact</code> command indicates that the specified instance, when appended to the object list, represents the complete OID.</td>
</tr>
<tr>
<td><strong>Example:</strong> RP/0/RSP0/CPU0:router(config-bulk-sc)# instance exact <code>interface FastEthernet 0/1.25</code> or RP/0/RSP0/CPU0:router(config-bulk-sc)# instance exact <code>interface FastEthernet 0/1.25</code></td>
<td>- The <code>instance wild</code> 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.</td>
</tr>
<tr>
<td><strong>Note</strong> Only one <code>instance</code> command can be configured per schema. If multiple <code>instance</code> commands are executed, the earlier ones are overwritten by new commands.</td>
<td>- The <code>instance range</code> command indicates a range of instances on which to collect data.</td>
</tr>
<tr>
<td><strong>Example:</strong> RP/0/RSP0/CPU0:router(config-bulk-sc)# instance range start 1 end 2 or RP/0/RSP0/CPU0:router(config-bulk-sc)# instance range start 1 end 2</td>
<td>- The <code>instance repetition</code> command indicates data collection to repeat for a certain number of instances of a MIB object.</td>
</tr>
<tr>
<td><strong>Example:</strong> RP/0/RSP0/CPU0:router(config-bulk-sc)# instance repetition 1 max 4</td>
<td></td>
</tr>
</tbody>
</table>

5. `poll-interval minutes`
6. `commit`
## 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

### DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> configure</td>
<td></td>
</tr>
<tr>
<td><strong>Step 2</strong> <code>snmp-server mib bulkstat transfer-id transfer-id</code></td>
<td>Identifies the transfer configuration with a name (transfer-id argument) and enters bulk statistics transfer configuration mode.</td>
</tr>
</tbody>
</table>

Example:

```
RP/0/RSP0/CPU0:router(config)# snmp-server mib bulkstat transfer bulkstat1
```
### Command or Action

**Step 3**

- **buffer-size** *bytes*

  **Example:**
  
  RP/0/RSP0/CPU0:router(config-bulk-tr)# buffersize 3072

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

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

**Step 4**

- **format** `{bulkBinary | bulkASCII | schemaASCII}`

  **Example:**
  
  RP/0/RSP0/CPU0:router(config-bulk-tr)# format schemaASCII

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

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

**Step 5**

- **schema** *schema-name*

  **Example:**
  
  RP/0/RSP0/CPU0:router(config-bulk-tr)# schema ATM2/0-IFMIB
  RP/0/RSP0/CPU0:router(config-bulk-tr)# schema ATM2/0-CAR
  RP/0/RSP0/CPU0:router(config-bulk-tr)# schema Ethernet2/1-IFMIB

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

**Step 6**

- **transfer-interval** *minutes*

  **Example:**
  
  RP/0/RSP0/CPU0:router(config-bulk-tr)# transfer-interval 20

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

**Step 7**

- **url primary** *url*

  **Example:**
  
  RP/0/RSP0/CPU0:router(config-bulk-tr)# url primary ftp://user:password@host/folder/bulkstat1

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

**Step 8**

- **url secondary** *url*

  **Example:**
  
  RP/0/RSP0/CPU0:router(config-bulk-tr)# url secondary tftp://10.1.0.1/tftpboot/user/bulkstat1

  **Purpose:**
  
  (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.
### Configuring Bulk Statistics Transfer Options

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 9</strong></td>
<td><strong>retry number</strong>&lt;br&gt;<strong>Example:</strong>&lt;br&gt;RP/0/RSP0/CP00:router(config-bulk-tr)# retry 1</td>
</tr>
<tr>
<td><strong>Step 10</strong></td>
<td><strong>retain minutes</strong>&lt;br&gt;<strong>Example:</strong>&lt;br&gt;RP/0/RSP0/CP00:router(config-bulk-tr)# retain 60</td>
</tr>
</tbody>
</table>
| **Step 11** | **enable**<br>**Example:**<br>RP/0/RSP0/CP00:router(config-bulk-tr)# enable | Begins the bulk statistics data collection and transfer process for this configuration.  
- For successful execution of this action, at least one schema with non-zero number of objects must be configured.  
- Periodic collection and file transfer begins only if this command is configured. Conversely, the no enable command stops the collection process. A subsequent enable starts the operations again.  
- Each time the collection process is started using the enable command, data is collected into a new bulk statistics file. When the no enable command is used, the transfer process for any collected data immediately begins (in other words, the existing bulk statistics file is transferred to the specified management station). |
| **Step 12** | **commit** |
What to do next

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

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

Monitoring Periodic MIB Data Collection and Transfer

SUMMARY STEPS

1. show snmp mib bulkstat transfer transfer-name

DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
</table>
| Step 1            | show snmp mib bulkstat transfer transfer-name | (Optional) The show command for this feature lists all bulk statistics virtual files (VFiles) on the system that have finished collecting data. (Data files that are not complete are not displayed.)

The output lists all of the completed local bulk statistics files, the remaining time left before the bulk statistics file is deleted (remaining retention period), and the state of the bulk statistics file.

The “STATE” of the bulk statistics file is one of the following:

- Queued--Indicates that the data collection for this bulk statistics file is completed (in other words, the transfer interval has been met) and that the bulk statistics file is waiting for transfer to the configured destination(s).

- Retry--Indicates that one or more transfer attempts have failed and that the file transfer will be attempted again. The number of retry attempts remaining are displayed in parenthesis.

- Retained--Indicates that the bulk statistics file has either been successfully transmitted or that the configured number of retries have been completed.
### Periodic MIB Data Collection and Transfer: Example

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

```plaintext
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
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
1.3.6.1.4.1.9.9.221.1.1.1.3 1.3.6.1.4.1.9.9.221.1.1.1.1.2

cemp1.cempWild: 133491515, 8695772.1, processor, 2

cemp1.cempWild: 133491515, 8695772.2, reserved, 11

cemp1.cempWild: 133491515, 8695772.3, image, 12

cemp1.cempWild: 133491515, 8695772.1, processor, 2

cemp1.cempWild: 133491515, 8695772.2, reserved, 11

cemp1.cempWild: 133491515, 8695772.3, image, 12
```

### Command or Action | Purpose
--- | ---
To display only the status of a named transfer (as opposed to all configured transfers), specify the name of the transfer in the transfer-name argument.

**show snmp mib bulkstat transfer Sample Output**

```
RP/0/RSP0/CPU0:router# show snmp mib bulkstat transfer

Transfer Name : ifmib

Retained files

File Name : Time Left (in seconds) :STATE
---------------------------------------------------------------------
ifmib_Router_020421_100554683 : 173 : Retry (2 Retry attempt(s) Left)
```
| System Management Configuration Guide for Cisco ASR 9000 Series Routers, IOS XR Release 6.2.x |

### Periodic MIB Data Collection and Transfer: Example

<table>
<thead>
<tr>
<th>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</th>
</tr>
</thead>
<tbody>
<tr>
<td>cempt1.cempRepeat: 1339491515, 8695772.1, processor, 2</td>
</tr>
<tr>
<td>cempt1.cempRepeat: 1339491515, 8695772.2, reserved, 11</td>
</tr>
<tr>
<td>cempt1.cempRepeat: 1339491515, 8695772.3, image, 12</td>
</tr>
<tr>
<td>cempt1.cempRepeat: 1339491515, 26932192.1, processor, 2</td>
</tr>
<tr>
<td>cempt1.cempRepeat: 1339491515, 26932192.2, reserved, 11</td>
</tr>
<tr>
<td>cempt1.cempRepeat: 1339491515, 26932192.3, image, 12</td>
</tr>
<tr>
<td>cempt1.cempRepeat: 1339491515, 35271015.1, processor, 2</td>
</tr>
<tr>
<td>cempt1.cempRepeat: 1339491515, 35271015.2, reserved, 11</td>
</tr>
<tr>
<td>cempt1.cempRepeat: 1339491515, 35271015.3, image, 12</td>
</tr>
<tr>
<td>cempt1.cempRepeat: 1339491515, 36631989.1, processor, 2</td>
</tr>
<tr>
<td>cempt1.cempRepeat: 1339491515, 36631989.2, reserved, 11</td>
</tr>
<tr>
<td>cempt1.cempRepeat: 1339491515, 36631989.3, image, 12</td>
</tr>
<tr>
<td>cempt1.cempRepeat: 1339491515, 52690955.1, processor, 2</td>
</tr>
<tr>
<td>cempt1.cempRepeat: 1339491515, 52690955.2, reserved, 11</td>
</tr>
<tr>
<td>cempt1.cempRepeat: 1339491515, 52690955.3, image, 12</td>
</tr>
</tbody>
</table>
Periodic MIB Data Collection and Transfer: Example
Configuring Flexible Command Line Interface

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

Table 14: Feature History for Configuring Flexible CLI Configuration Groups

<table>
<thead>
<tr>
<th>Release</th>
<th>Modification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Release 4.3.1</td>
<td>Flexible CLI configuration groups were introduced.</td>
</tr>
</tbody>
</table>

This module contains these topics:

- Information About Flexible CLI Configuration Groups, on page 85
- Flexible Configuration Restrictions, on page 86
- Configuring a Configuration Group, on page 87
- Verifying the Configuration of Configuration Groups, on page 90
- Apply Groups Priority Inheritance, on page 91
- Regular Expressions in Configuration Groups, on page 92
- Configuration Examples for Flexible CLI Configuration, on page 103

Information About 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:

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

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

```plaintext
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.*|POS.* — To match on either TenGigE.* or POS.*.
```

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 0/0/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 gigabitethernet0/4/1/0
  apply-group G-INTERFACE
```

This configuration is not permitted because it cannot be determined whether the interface gigabitethernet0/4/1/0 configuration inherits mtu 1500 or mtu 2000. Both expressions in the configuration group match gigabitethernet0/4/1/0.

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

Use multi-line configuration style to configure Flexible CLI configuration groups (like group or apply-group commands) by entering each configuration mode in a separate line, one configuration per line. This is important so that the configuration properties are fully inherited and for better readability during troubleshooting.

Example for a correct configuration style is:

```
RP/0/RSP0/CPU0:router# configure
RP/0/RSP0/CPU0:router(config)# router isis lgp
RP/0/RSP0/CPU0:router(config-isis)# interface Ten 0/4/0/0
RP/0/RSP0/CPU0:router(config-isis-if)# address-family ipv4 unicast
RP/0/RSP0/CPU0:router(config-isis-if-sf)# metric 123
```

### 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

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> configure</td>
<td>Specifies a name for a configuration group and enters group configuration mode to define the group. The <code>group-name</code> argument can have up to 32 characters and cannot contain any special characters. For information regarding special characters, refer to the Understanding Regular Expressions, Special Characters, and Patterns module in the Cisco ASR 9000 Series Aggregation Services Router Getting Started Guide.</td>
</tr>
<tr>
<td><strong>Step 2</strong> group <code>group-name</code></td>
<td>Specifies the configuration statements that you want included in this configuration group. For more information regarding the use of regular expressions, see Regular Expressions in Configuration Groups, on page 92. This example is applicable to all Gigabit Ethernet interfaces.</td>
</tr>
</tbody>
</table>

**Example:**

```
RP/0/RSP0/CPU0:router(config)# group g-interf
```

<table>
<thead>
<tr>
<th><strong>Step 3</strong> end-group</th>
<th>Completes the configuration of a configuration group and exits to global configuration mode.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 4</strong> apply-group</td>
<td>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.</td>
</tr>
</tbody>
</table>

**Example:**

```
RP/0/RSP0/CPU0:router(config-if)# apply-group
```

The MTU value from the group `g-interf` is applied to the interface GigabitEthernet0/2/0/0. If this group is applied in
Simple Configuration Group: Example

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

```
RP/0/RSP0/CPU0:router(config)# group g-logging
RP/0/RSP0/CPU0:router(config-GRP)# logging trap notifications
RP/0/RSP0/CPU0:router(config-GRP)# logging console debugging
RP/0/RSP0/CPU0:router(config-GRP)# logging monitor debugging
RP/0/RSP0/CPU0:router(config-GRP)# logging buffered 10000000
RP/0/RSP0/CPU0:router(config-GRP)# end-group

RP/0/RSP0/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/RSP0/CPU0:router(config)# group g-interfaces
RP/0/RSP0/CPU0:router(config-GRP)# interface 'FastEthernet.*'
RP/0/RSP0/CPU0:router(config-GRP-if)# mtu 1500
RP/0/RSP0/CPU0:router(config-GRP-if)# exit
RP/0/RSP0/CPU0:router(config-GRP)# interface 'GigabitEthernet.*'
RP/0/RSP0/CPU0:router(config-GRP-if)# mtu 1000
RP/0/RSP0/CPU0:router(config-GRP-if)# exit
RP/0/RSP0/CPU0:router(config-GRP)# interface 'POS.*'
RP/0/RSP0/CPU0:router(config-GRP-if)# mtu 2000
RP/0/RSP0/CPU0:router(config-GRP-if)# end-group
```

This group can be applied to Fast Ethernet, Gigabit Ethernet or POS interfaces, 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/RSP0/CPU0:router(config)# interface GigabitEthernet0/2/0/0
RP/0/RSP0/CPU0:router(config-if)# apply-group g-interfaces
RP/0/RSP0/CPU0:router(config-if)# ipv4 address 2.2.2.2 255.255.255.0
```

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

```
RP/0/RSP0/CPU0:router(config)# interface FastEthernet0/2/0/0
RP/0/RSP0/CPU0:router(config-if)# apply-group g-interfaces
```
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 config-command`

DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td>Show running-config group [group-name]</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>Displays the contents of a specific or all configured configuration groups.</td>
</tr>
<tr>
<td><code>show running-config group [group-name]</code></td>
<td></td>
</tr>
</tbody>
</table>
| `group g-int-ge
interface 'GigabitEthernet.*'
mtu 1000
negotiation auto
!` | |
| `end-group` | |

| **Step 2** | Show running-config |
| **Example:** | 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 POS0/4/1/1, 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. |
| `show running-config` | |
| `group G-INTERFACE-MTU
interface 'POS.*'
mtu 1500
!` | |
| `end-group` | |
| `interface POS0/4/1/0
apply-group G-INTERFACE-MTU
!` | |
| `interface POS0/4/1/1
apply-group G-INTERFACE-MTU` | |
| `mtu 2000` | |
### Apply Groups Priority Inheritance

The inheritance is supported according to the priority.

Apply groups priority inheritance helps flexible configuration groups handle common configuration statements between groups. When multiple configuration groups have common configuration statements, the inheritance priority is configuration statements present in inner groups have precedence over configuration statements present in outer groups. Tiebreaker is determined by the system order (lexicographical) of the regular expressions. User defined order of commands are not accepted.

For example, a configuration statement in configuration group ONE has precedence over any other group. A configuration statement in configuration group SEVEN is used only if it is not contained in any other group. Within a configuration group, inheritance priority is lengthiest match.

```plaintext
apply-group SIX SEVEN
router ospf 0
apply-group FOUR FIVE
```
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.

For general information regarding regular expressions, refer to the Understanding Regular Expressions, Special Characters, and Patterns module in the Cisco ASR 9000 Series Aggregation Services Router Getting Started Guide.

Note
Not all POSIX regular expressions are supported. Refer to Flexible Configuration Restrictions, on page 86 for more information.

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/RSP0/CPU0:router(config-GRP)# interface ?
ATM         'RegExp': ATM Network Interface(s)
BVI         'RegExp': Bridge-Group Virtual Interface
Bundle-Ether 'RegExp': Aggregated Ethernet interface(s)
Bundle-POS  'RegExp': Aggregated POS interface(s)
GigabitEthernet 'RegExp': GigabitEthernet/IEEE 802.3 interface(s)
IMA         'RegExp': ATM Network Interface(s)
Loopback    'RegExp': Loopback interface(s)
```
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:

```plaintext
group g-l2t
  interface 'Gi.*\..' l2transport
  .
end-group

group g-pty
  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:

```plaintext
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:

```plaintext
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:

```plaintext
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:

```plaintext
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:

```plaintext
group g-invalid
interface '.*'
  bundle port-priority 10
!
interface '.!*Ethemet.*'
  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 '.!*Ethemet.*' 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.
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/RSP0/CPU0:router(config)#group FB_flexi_snmp
RP/0/RSP0/CPU0:router(config-GRP)# snmp-server vrf '.*'
RP/0/RSP0/CPU0:router(config-GRP-snmp-vrf)# host 1.1.1.1 traps version 2c group_1
RP/0/RSP0/CPU0:router(config-GRP-snmp-vrf)# host 1.1.1.1 informs version 2c group_1
RP/0/RSP0/CPU0:router(config-GRP-snmp-vrf)# context group_1
RP/0/RSP0/CPU0:router(config-GRP-snmp-vrf)#commit
RP/0/RSP0/CPU0:router(config-GRP-snmp-vrf)#root
RP/0/RSP0/CPU0:router(config)#snmp-server vrf vrf1
RP/0/RSP0/CPU0:router(config)#snmp-server vrf vrf10
RP/0/RSP0/CPU0:router(config)#snmp-server vrf vrf100
RP/0/RSP0/CPU0:router(config)#commit
RP/0/RSP0/CPU0:router(config)#apply-group FB_flexi_snmp
RP/0/RSP0/CPU0:router(config)#do sh running-config group
RP/0/RSP0/CPU0:router(config)#show running-config inheritance detail
```

```
RP/0/RSP0/CPU0:router(config)#group FB_flexi_snmp
RP/0/RSP0/CPU0:router(config)#snmp-server vrf '.*'
RP/0/RSP0/CPU0:router(config)#host 1.1.1.1 traps version 2c group_1
RP/0/RSP0/CPU0:router(config)#host 1.1.1.1 informs version 2c group_1
RP/0/RSP0/CPU0:router(config)#context group_1
RP/0/RSP0/CPU0:router(config)#end-group
```

```
RP/0/RSP0/CPU0:router(config)#apply-group FB_flexi_snmp
RP/0/RSP0/CPU0:router(config)#snmp-server vrf vrf1
RP/0/RSP0/CPU0:router(config)#snmp-server vrf vrf10
RP/0/RSP0/CPU0:router(config)#snmp-server vrf vrf100
RP/0/RSP0/CPU0:router(config)#show running-config group
RP/0/RSP0/CPU0:router(config)#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 expressions `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 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.

```plaintext
apply-group SIX SEVEN
router ospf 0
  apply-group FOUR FIVE
area 0
apply-group THREE
  interface GigabitEthernet 0/0/0/0
    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 GigabitEthernet 0/0/0/0** 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/RSP0/CPU0:router(config)# group g-isis-gige
RP/0/RSP0/CPU0:router(config-GRP)# router isis '.*'
RP/0/RSP0/CPU0:router(config-GRP-isis)# interface 'GigabitEthernet.*'
RP/0/RSP0/CPU0:router(config-GRP-isis-if)# lsp-interval 20
RP/0/RSP0/CPU0:router(config-GRP-isis-if)# hello-interval 40
RP/0/RSP0/CPU0:router(config-GRP-isis-if)# address-family ipv4 unicast
RP/0/RSP0/CPU0:router(config-GRP-isis-if-af)# metric 10
RP/0/RSP0/CPU0:router(config-GRP-isis-if-af)# end-group
RP/0/RSP0/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/RSP0/CPU0:router(config)# group g-ospf
RP/0/RSP0/CPU0:router(config-GRP)# router ospf '.*'
RP/0/RSP0/CPU0:router(config-GRP-ospf)# nsf cisco
RP/0/RSP0/CPU0:router(config-GRP-ospf)# packet-size 3000
RP/0/RSP0/CPU0:router(config-GRP-ospf)# end-group
RP/0/RSP0/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/RSP0/CPU0:router(config)# group g-ospf
RP/0/RSP0/CPU0:router(config-GRP)# router ospf '.*'
RP/0/RSP0/CPU0:router(config-GRP-ospf)# area '.*'
RP/0/RSP0/CPU0:router(config-GRP-ospf-areas)# packet-size 2000
RP/0/RSP0/CPU0:router(config-GRP-ospf-areas)# end-group
RP/0/RSP0/CPU0:router(config)# apply-group g-ospf

RP/0/RSP0/CPU0:router(config)# router ospf 200
RP/0/RSP0/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/RSP0/CPU0:router(config)# group g-l2trans-if
RP/0/RSP0/CPU0:router(config-GRP)# interface 'TenGigE.*' l2transport
RP/0/RSP0/CPU0:router(config-GRP)# mtu 1514
RP/0/RSP0/CPU0:router(config-GRP)# end-group

RP/0/RSP0/CPU0:router(config)# interface TenGigE0/0/0/0.1 l2transport
RP/0/RSP0/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/RSP0/CPU0:router(config)# group g-ospf2
RP/0/RSP0/CPU0:router(config-GRP)# router ospf '.*'
RP/0/RSP0/CPU0:router(config-GRP-ospf)# area '.*'
RP/0/RSP0/CPU0:router(config-GRP-ospf-ar)# cost 2
RP/0/RSP0/CPU0:router(config-GRP-ospf-ar)# end-group

RP/0/RSP0/CPU0:router(config)# group g-ospf100
RP/0/RSP0/CPU0:router(config-GRP)# router ospf '.*'
RP/0/RSP0/CPU0:router(config-GRP-ospf)# area '.*'
RP/0/RSP0/CPU0:router(config-GRP-ospf-ar)# cost 100
RP/0/RSP0/CPU0:router(config-GRP-ospf-ar)# end-group
```
If these configuration groups are applied as follows, the cost 2 specified in \texttt{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 \texttt{g-ospf100} is ignored.

\begin{verbatim}
RP/0/RSP0/CPU0:router(config)\# router ospf 0
RP/0/RSP0/CPU0:router(config-ospf)\# apply-group g-ospf100
RP/0/RSP0/CPU0:router(config-ospf)\# area 0
RP/0/RSP0/CPU0:router(config-ospf-ar)\# apply-group g-ospf2
\end{verbatim}

\section*{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:

\begin{verbatim}
group g-interface-mtu
  interface 'POS.*'
    mtu 1500
  !
end-group

interface POS0/4/1/0
  apply-group g-interface-mtu
  !
\end{verbatim}

Now you change the configuration group as in this example:

\begin{verbatim}
RP/0/RSP0/CPU0:router(config)\# group g-interface-mtu
RP/0/RSP0/CPU0:router(config-GRP)\# interface 'POS.*'
  mtu 2000
RP/0/RSP0/CPU0:router(config-GRP-if)\# end-group

When this configuration group is committed, the MTU configuration for interface POS0/4/1/0 is automatically updated to 2000.

\section*{Configuration Examples for Flexible CLI Configuration}

\subsection*{Basic Flexible CLI Configuration: Example}

This example shows that the Media Access Control (MAC) accounting configuration from the \texttt{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:

\begin{verbatim}
RP/0/RSP0/CPU0:router\# show running group gd21

  group gd21
  interface 'GigabitEthernet0/0/0/2[1-9]'
  description general interface inheritance check
\end{verbatim}
load-interval 30
cmac-accounting ingress
cmac-accounting egress
!
end-group

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

RP/0/RSP0/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/RSP0/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/RSP0/CPU0:router# show running 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
cmac-accounting ingress
## Inherited from group gd21
cmac-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
cmac-accounting ingress
## Inherited from group gd21
cmac-accounting egress
!
!

5. Verify that the inherited configuration actually takes effect:

RP/0/RSP0/CPU0:router# show mac 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
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/RSP0/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/RSP0/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/RSP0/CPU0:router# show running interface gigabitEthernet0/0/0/30
   interface GigabitEthernet0/0/0/30
   !
   RP/0/RSP0/CPU0:router# show running inheritance interface gigabitEthernet0/0/0/30
   interface GigabitEthernet0/0/0/30
   ## Inherited from group l2tr
   mtu 1500
   !
   RP/0/RSP0/CPU0:router# show running interface gigabitEthernet0/0/0/9.800
   interface GigabitEthernet0/0/0/9.800
   encapsulation dot1q 800
   !
   RP/0/RSP0/CPU0:router# show running inheritance interface gigabitEthernet0/0/0/9.800
   interface GigabitEthernet0/0/0/9.800
   ## Inherited from group l2tr
   mtu 1400
   encapsulation dot1q800
   !
   RP/0/RSP0/CPU0:router# show running interface gigabitEthernet0/0/0/9.250
   interface GigabitEthernet0/0/0/9.250
   !
interface GigabitEthernet0/0/0/9.250 l2transport
    encapsulation dot1q 250

RP/0/RSP0/CPU0:router# show running inheritance interface gigabitEthernet0/0/0/800

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

## Inherited from group l2tr
    mtu 1400

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

RP/0/RSP0/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/RSP0/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 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/RSP0/CPU0:router# show interface gigabitEthernet 0/0/0/9.250
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/RSP0/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/RSP0/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/RSP0/CPU0:router# show running interface gigabitEthernet 0/0/0/30
   interface GigabitEthernet0/0/0/30
   !
   RP/0/RSP0/CPU0:router# show running inheritance interface GigabitEthernet 0/0/0/30
   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
   !
   ```
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/RSP0/CPU0:router# show running interface gigabitEthernet 0/0/39
interface GigabitEthernet0/0/39
ipv4 access-group smany ingress
ipv4 access-group smany egress

RP/0/RSP0/CPU0:router# show running interface gigabitEthernet 0/0/38
interface GigabitEthernet0/0/38
!

RP/0/RSP0/CPU0:router# show running ipv4 access-list smany
ipv4 access-list smany
10 permit ipv4 any any
!

RP/0/RSP0/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/RSP0/CPU0:router# show running group acref

group acref
interface 'GigabitEthernet0/0/3.**'
ipv4 access-group adem ingress
```
3. Check the concise and inheritance views for the matching interface where the access list reference is configured locally:

```
RP/0/RSP0/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/RSP0/CPU0:router# show running inheritance interface gigabitEthernet 0/0/0/39
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/RSP0/CPU0:router# show running interface gigabitEthernet 0/0/0/38
interface GigabitEthernet0/0/0/38
```

```
RP/0/RSP0/CPU0:router# show running inheritance interface gigabitEthernet 0/0/0/38
interface GigabitEthernet0/0/0/38
  ## Inherited from group l2tr
  ## 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/RSP0/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/RSP0/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/RSP0/CPU0:router# show running group isis2

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

RP/0/RSP0/CPU0:router# show running | inc apply-group

Building configuration...

apply-group isis 12tr isis2 mpp bundle1 acref

3. Check the inheritance view of the ISIS configuration:

RP/0/RSP0/CPU0:router# show running inheritance 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
    ## 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
  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/RSP0/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/RSP0/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/RSP0/CPU0:router# show running group go-a

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

RP/0/RSP0/CPU0:router# show running group go-b

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

RP/0/RSP0/CPU0:router# show running group go-c

group go-c
  router ospf ".*"
    area ".*"
      interface 'Gig.*'
3. Check the inheritance view and verify that the apply-group in the lowest configuration submode gets the highest priority:

RP/0/RSP0/CPU0:router# show running inheritance router ospf 1

router ospf 1
nsr
router-id 121.121.121.121
cpyisco
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/RSP0/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/RSP0/CPU0:router# show running group bundle1
   group bundle1
   interface 'GigabitEthernet0/1/0/1[1-6]' bundle id 1 mode active
   !
   end-group
   ```

   ```
   RP/0/RSP0/CPU0:router# show running | inc apply-group
   Building configuration...
   apply-group isis l2tr isis2 mpp bundle1
   ```

2. Check the local configuration:

   ```
   RP/0/RSP0/CPU0:router# show running interface gigabitEthernet 0/1/0/11
   interface GigabitEthernet0/1/0/11
   !
   RP/0/RSP0/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/RSP0/CPU0:router# show running inheritance interface GigabitEthernet 0/1/0/11
   interface GigabitEthernet0/1/0/11
   ## Inherited from group bundle1
   ```
bundle id 1 mode active

4. Check that the inheritance configuration took effect:

RP/0/RSP0/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
Managing Router Hardware

This chapter describes the command-line interface (CLI) techniques and commands used to manage and configure the hardware components of a router running the Cisco IOS XR software.

For complete descriptions of the commands listed in this module, see Additional References, on page 154. To locate documentation for other commands that might appear in the course of performing a configuration task, search online in Cisco ASR 9000 Series Aggregation Services Router Commands Master List.

### Table 15: Feature History for Managing Router Hardware with Cisco IOS XR Software

<table>
<thead>
<tr>
<th>Release</th>
<th>Modification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Release 3.7.2</td>
<td>This feature was introduced.</td>
</tr>
<tr>
<td>Release 3.9.0</td>
<td>No modification.</td>
</tr>
</tbody>
</table>

This module contains the following topics:

- Prerequisites for Managing Router Hardware, on page 119
- Displaying Hardware Status, on page 120
- RSP Redundancy and Switchover, on page 136
- Console Management Port, on page 140
- CPAK, on page 144
- Reloading, Shutting Down, or Power Cycling a Node, on page 146
- Flash Disk Recovery, on page 148
- Using Controller Commands to Manage Hardware Components, on page 149
- Formatting Hard Drives, Flash Drives, and Other Storage Devices, on page 149
- Removing and Replacing Cards, on page 150
- Upgrading the CPU Controller Bits, on page 153
- Additional References, on page 154

## Prerequisites for Managing Router Hardware

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.
Displaying Hardware Status

This section describes how to display different types of hardware status information.

Displaying SDR Hardware Version Information

To display hardware version information for the components assigned to a secure domain router (SDR), connect to the designated shelf controller (DSC) and enter the `show diag` command in EXEC mode. The displayed information includes the card serial number and the ROMMON software version.

The syntax for the `show diag` command in EXEC mode is:

```
show diag [node-id | details | summary]
```

In the following example, the `show diag` command displays information for all nodes in the SDR:

```
RP/0/RSP0/CP00:router# show diag
Mon Jun 29 00:36:41.576 PST

NODE module 0/RSP0/CP00 :

  MAIN: board type 0x100302
  S/N:   FOC1230803H
  Top Assy. Number:  68-3160-04
  PID:   A2K-RSP-4G-HDD=
  UDI_VID:  VP4
  HwRev:  V4.8
  New Deviation Number: 0
  CLEI:  IPUCARJBA
  Board State : IOS XR RUN
  FLD:   Motherboard: N/A, Processor: 0x8004 (rev: 2.2), Power: N/A
  MONLIB: QNXFFS Monlib Version 3.2
  ROMMON: Version 1.0(20081208:173612) [ASR9K ROMMON]
  Board FPGA/ CPLD/ASIC Hardware Revision:
    Compact Flash : V1.0
    XbarSwitch0 : V1.3
    XbarSwitch1 : V1.3
    XbarArbiter : V1.0
    XbarInterface : V0.0
    IntCtrl : V1.14
    CLKctrl : V1.13
    PuntFPGA : V1.5
    HD : V3.0
    USB0 : V77.20
    USB1 : V77.20
    CPUCtrl : V1.17
    UTI : V1.6
    LIU : V1.0
    MLANSwitch : V0.0
    EOBCSwitch : V2.0
    CBC (active partition) : v1.2
    CBC (inactive partition) : v1.1

NODE module 0/1/CP00 :

  MAIN: board type 0x20207
  S/N:   FOC123081J6
```
Top Assy. Number: 68-3182-03
PID: A9K-40GE-B
UDI_VID: V1D
HwRev: V0.0
New Deviation Number: 0
CLEI:
Board State: IOS XR RUN
PLD: Motherboard: N/A, Processor: 0x8004 (rev: 2.2), Power: N/A
ROMMON: Version 1.0 (20081208:174521) [ASR9K ROMMON]
Board FPGA/CPLD/ASIC Hardware Revision:
NP0: V3.194
NP1: V3.194
NP2: V3.194
NP3: V3.194
XbarInterface: V18.4
Bridge0: V0.38
Bridge1: V0.38
CPUCtrl: V0.15
USB: V77.20
PortCtrl: V0.8
PHYCtrl: v0.6
40 Port Gigabit Ethernet Daughter board: V0.0
CBC (active partition): v2.2
CBC (inactive partition): v2.1

NODE module 0/4/CPU0:
MAIN: board type 0x2020a
S/N: FCI123081JA
Top Assy. Number: 68-3183-02
PID: A9K-8T4-B
UDI_VID: V1D
HwRev: V0.0
New Deviation Number: 0
CLEI: IPU3AE0CAA
Board State: IOS XR RUN
PLD: Motherboard: N/A, Processor: 0x8004 (rev: 2.2), Power: N/A
ROMMON: Version 1.0 (20081208:174521) [ASR9K ROMMON]
Board FPGA/CPLD/ASIC Hardware Revision:
NP0: V3.194
NP1: V3.194
NP2: V3.194
NP3: V3.194
XbarInterface: V18.4
Bridge0: V0.38
Bridge1: V0.38
CPUCtrl: V0.15
USB: V77.20
PortCtrl: V0.8
PHYCtrl: V0.6
PHY0: V0.16
PHY1: V0.16
PHY2: V0.16
PHY3: V0.16
PHY4: V0.16
PHY5: V0.16
PHY6: V0.16
PHY7: V0.16
8 Port Ten Gigabit Ethernet Daughter board: V0.0
CBC (active partition): v2.2
CBC (inactive partition): v2.1

NODE module 0/6/CPU0:
In the following example, the `show diag` command displays information for a single node:

```
RP/0/RSP0/CPU0:router# show diag 0/6/cpu0
Mon Jun 29 00:41:43.450 PST

NODE module 0/6/CPU0 :

    MAIN: board type 0x20208
    S/N:    FHH12250033
    Top Assy. Number:  68-3184-02
    PID:    A9K-4T-B
    UDI_VID: V1D
    HwRev:  V0.0
    New Deviation Number: 0
    CLEI:
    Board State : IOS XR RUN
    PLD:      Motherboard: N/A, Processor: 0x8004 (rev: 2.2), Power: N/A
    ROMMON:  Version 1.0(20081208:174521) [ASR9K ROMMON]
    Board FPGA/CPLD/ASIC Hardware Revision:
        NP0 : V3.194
        NP1 : V3.194
        NP2 : V3.194
        NP3 : V3.194
        XbarInterface : V18.4
        Bridge0 : V0.38
        Bridge1 : V0.38
        CPUCtrl : V0.15
        USB : V77.20
        PHY0 : V0.16
        PHY1 : V0.16
        PHY2 : V0.16
        PHY3 : V0.16
        PortCtrl : V0.10
        PHYCtrl : V0.7
        4 Port Ten Gigabit Ethernet Daughter board : V0.0
        CBC (active partition) : v2.2
        CBC (inactive partition) : v2.1
```
Displaying System Hardware Version Information

To display hardware version information for all or some of the components assigned in a system, connect to the designated shelf controller (DSC) and enter the `show diag` command in administration EXEC mode. When this command is entered in administration EXEC mode, you can display information on RSPs, line cards, and system components such as the chassis, fan trays, and power supplies.

Note
If you enter the `show diag` command in EXEC mode, the software displays only the hardware assigned to the SDR to which you are connected.

The syntax for the `show diag` command in administration EXEC mode is:

```
show diag [node-id | chassis | details | fans | memory | power-supply | summary]
```

Tip
For information on the software version, use the `show version` command.

In the following example, the `show diag` command displays information for all nodes in the system:

```
RP/0/RSP0/CPU0:router(admin)# show diag
Mon Jun 29 01:21:04.571 PST

NODE module 0/RSP0/CPU0 :

MAIN:  board type 0x100302
     S/N:  FOC1230803H
     Top Assy. Number: 68-3160-04
     PID:  A2K-RSP-4G-HDD=
     UDI_VID:  VP4
     HwRev:  V4.8
     New Deviation Number: 0
     CLEI:  IPUCARJBAA
     Board State : IOS XR RUN
     PLD:  Motherboard: N/A, Processor: 0x8004 (rev: 2.2), Power: N/A
     MONLIB:  QNXFFS Monlib Version 3.2
     ROMMON:  Version 1.0(20081208:173612) [ASR9K ROMMON]
     Board FPGA/CPLD/ASIC Hardware Revision:
       Compact Flash : V1.0
       XbarSwitch0 : V1.3
       XbarSwitch1 : V1.3
       XbarArbiter : V1.0
       XbarInterface : V0.0
       IntCtrl : V1.14
```
ClkCtrl : V1.13
PuntFPGA : V1.5
HD : V3.0
USB0 : V77.20
USB1 : V77.20
CPUctrl : V1.17
UTI : V1.6
LIU : V1.0
MLANSwitch : V0.0
EOBCSwitch : V2.0
CBC (active partition) : v1.2
CBC (inactive partition) : v1.1

NODE fantray 0/FT0/SP:
MAIN: board type 0x900211
S/N:
Top Assy. Number: 32-0000-00
PID:
UDI_VID:
HwRev: V32.0
New Deviation Number: 0
CLEI:
PLD: Motherboard: N/A, Processor: N/A, Power: N/A
ROMMON:
Board FPGA/CPLD/ASIC Hardware Revision:
CBC (active partition) : v4.0
CBC (inactive partition) : v0.13

NODE fantray 0/FT1/SP:
MAIN: board type 0x900211
S/N:
Top Assy. Number: 32-0000-00
PID:
UDI_VID:
HwRev: V32.0
New Deviation Number: 0
CLEI:
PLD: Motherboard: N/A, Processor: N/A, Power: N/A
ROMMON:
Board FPGA/CPLD/ASIC Hardware Revision:
CBC (active partition) : v4.0
CBC (inactive partition) : v0.13

NODE module 0/1/CPU0:
MAIN: board type 0x20207
S/N: FOC123081J6
Top Assy. Number: 68-3182-03
PID:
UDI_VID: V1D
HwRev: V0.0
New Deviation Number: 0
CLEI:
Board State : IOS XR RUN
PLD: Motherboard: N/A, Processor: 0x8004 (rev: 2.2), Power: N/A
ROMMON: Version 1.0(20081208:174521) [ASR9K ROMMON]
Board FPGA/CPLD/ASIC Hardware Revision:
NP0 : V3.194
NP1 : V3.194
NP2 : V3.194
NP3 : V3.194
XbarInterface : V18.4
Displaying System Hardware Version Information

NODE module 0/4/CPU0 :

MAIN: board type 0x2020a
S/N: FOC12081JA
Top Assy. Number: 68-3183-02
PID: A9K-8T/4-B
UDI_VID: V1D
HwRev: V0.0
New Deviation Number: 0
CLEI: IPU3AE0CAA
Board State : IOS XR RUN
PLD: Motherboard: N/A, Processor: 0x8004 (rev: 2.2), Power: N/A
ROMMON: Version 1.0(20081208:174521) [ASR9K ROMMON]
Board FPGA/CPLD/ASIC Hardware Revision:
  NP0 : V3.194
  NP1 : V3.194
  NP2 : V3.194
  NP3 : V3.194
  XbarInterface : V18.4
Bridge0 : V0.38
Bridge1 : V0.38
CPUCtrl : V0.15
USB : V77.20
PortCtrl : V0.10
PHYCtrl : V0.7
PHY0 : V0.16
PHY1 : V0.16
PHY2 : V0.16
PHY3 : V0.16
PHY4 : V0.16
PHY5 : V0.16
PHY6 : V0.16
PHY7 : V0.16
8 Port Ten Gigabit Ethernet Daughter board : V0.0
CBC (active partition) : v2.2
CBC (inactive partition) : v2.1

NODE module 0/6/CPU0 :

MAIN: board type 0x20208
S/N: FHH12250033
Top Assy. Number: 68-3184-02
PID: A9K-4T-B
UDI_VID: V1D
HwRev: V0.0
New Deviation Number: 0
CLEI:
Board State : IOS XR RUN
PLD: Motherboard: N/A, Processor: 0x8004 (rev: 2.2), Power: N/A
ROMMON: Version 1.0(20081208:174521) [ASR9K ROMMON]
Board FPGA/CPLD/ASIC Hardware Revision:
  NP0 : V3.194
  NP1 : V3.194
  NP2 : V3.194
Displaying System Hardware Version Information

NP3 : V3.194
XbarInterface : V18.4
Bridge0 : V0.38
Bridge1 : V0.38
CPUCtrl : V0.15
USB : V77.20
PHY0 : V0.16
PHY1 : V0.16
PHY2 : V0.16
PHY3 : V0.16
PortCtrl : V0.10
PHYCtrl : V0.7
4 Port Ten Gigabit Ethernet Daughter board : V0.0
CBC (active partition) : v2.2
CBC (inactive partition) : v2.1

NODE power-module 0/PM0/SP :

MAIN:  board type 0xf00188
S/N:
Top Assy. Number:  341-00032-01
PID:  A9K-3KW-AC
UDI_VID:  V00
HwRev:  V0.0
New Deviation Number: 0
CLEI:  ACACACACAC
PLD:  Motherboard: N/A, Processor: N/A, Power: N/A
ROMMON:
Board FPGA/CPLD/ASIC Hardware Revision:

NODE power-module 0/PM1/SP :

MAIN:  board type 0xf00188
S/N:
Top Assy. Number:  341-00032-01
PID:  A9K-3KW-AC
UDI_VID:  V00
HwRev:  V0.0
New Deviation Number: 0
CLEI:  ACACACACAC
PLD:  Motherboard: N/A, Processor: N/A, Power: N/A
ROMMON:
Board FPGA/CPLD/ASIC Hardware Revision:

NODE power-module 0/PM2/SP :

MAIN:  board type 0xf00188
S/N:
Top Assy. Number:  341-00032-01
PID:  A9K-3KW-AC
UDI_VID:  V00
HwRev:  V0.0
New Deviation Number: 0
CLEI:  ACACACACAC
PLD:  Motherboard: N/A, Processor: N/A, Power: N/A
ROMMON:
Board FPGA/CPLD/ASIC Hardware Revision:

Rack 0 - ASR-9010 Chassis, Includes Accessories
RACK NUM:  0
S/N:
PID:  ASR-9010 Backplane
VID:  0.1
Desc:  ASR-9010 Chassis, Includes Accessories
In the following example, the `show diag` command displays information for a single system component:

```
RP/0/RSP0/CPU0:router(admin)# show diag chassis
Mon Jun 29 01:25:05.711 PST
Rack 0 - ASR-9010 Chassis, Includes Accessories
   RACK NUM: 0
   P/N:     ASR-9010 Backplane
   S/N:     0
   VID:     0.1
   Desc:    ASR-9010 Chassis, Includes Accessories
   CLEI:    NOCLEI
   Top Assy. Number: 68-1234-56
```

### Displaying Software and Hardware Information

The `show version` command displays a variety of system information, including the hardware and software versions, router uptime, boot settings (including the configuration register), and active software.

The following is sample output from the `show version` command:

```
RP/0/RP0/CPU0:router# show version
Sat Aug 1 22:52:39.089 DST
Cisco IOS XR Software, Version 3.9.0.16I
Copyright (c) 2009 by Cisco Systems, Inc.
ROM: System Bootstrap, Version 1.1(20090521:183759) [ASR9K ROMMON],
rules router uptime is 1 day, 2 hours, 34 minutes
System image file is "bootflash:disk0/asr9k-os-mbi-3.9.0.16I/mbiasr9k-rp.vm"
cisco ASR9K Series (MPC8641D) processor with 4194304K bytes of memory.
MPC8641D processor at 1333MHz, Revision 2.2
2 Management Ethernet
12 TenGigE
40 GigabitEthernet
219k bytes of non-volatile configuration memory.
975M bytes of compact flash card.
3394M bytes of hard disk.
1605616k bytes of disk0: (Sector size 512 bytes).
1605616k bytes of disk1: (Sector size 512 bytes).
Configuration register on node 0/RSP0/CPU0 is 0x102
Boot device on node 0/RSP0/CPU0 is disk0:
Package active on node 0/RSP0/CPU0:
asr9k-scfclient, V 3.9.0.16I[DT_IMAGE], Cisco Systems, at disk0:asr9k-scfclient-3.9.0.16I
   Built on Thu Jul 30 12:09:40 DST 2009
   By sjc-lds-208 in /auto/ioxbuild7/production/3.9.0.16I.DT_IMAGE/asr9k/workspace for
   c4.2.1-p0
```
Displaying SDR Node IDs and Status

In EXEC mode, the `show platform` command displays information for all nodes assigned to the owner SDR. For each node, this information includes the host card type, the operational state, and the configuration state. To display information on a single node, enter the command with a node ID.

The syntax for the `show platform` command is:

```
show platform [node-id]
```

The following example displays the status for all nodes in the SDR to which you are connected:

```
RP/0/RSP0/CPU0:router# show platform
Mon Aug  3 07:39:01.416 DST
Node Type State Config State
--------------------------------------------------------------------------------------------------
0/RSP0/CPU0 A9K-RSP-4G(Active) IOS XR RUN PWR,NSSHUT,MON
0/1/CPU0 A9K-40GE-B IOS XR RUN PWR,NSSHUT,MON
0/4/CPU0 A9K-8T/4-B IOS XR RUN PWR,NSSHUT,MON
0/6/CPU0 A9K-4T-B IOS XR RUN PWR,NSSHUT,MON
```

The `node-id` appears in the `rack/slot/module` notation, and the `node-id` components are as follows:

- **rack** — In a single-shelf system the rack number is always “0.”
- **slot** — Number of the physical slot in which the card is installed.
- **module** — Subslot number of a system hardware component.

Table 16: Node ID Components, on page 129 summarizes the `node-id` for each type of card.
### Table 16: Node ID Components

<table>
<thead>
<tr>
<th>Card Type (the card to which your are issuing commands)</th>
<th>Rack (always “0&quot;)</th>
<th>Slot (the physical slot in which the card is installed)</th>
<th>Module (the entity on the card that is the target of the command)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Route switch processor</td>
<td>0</td>
<td>RSP0 and RSP1</td>
<td>CPU0</td>
</tr>
<tr>
<td>40-Port Gigabit Ethernet Line Card</td>
<td>0-255</td>
<td>4-7 (6-slot chassis)</td>
<td>0-X (SFP and XFP module number on the line card)</td>
</tr>
<tr>
<td>8-Port 10-Gigabit Ethernet Line Card</td>
<td></td>
<td>0-7 (10-slot chassis)</td>
<td></td>
</tr>
<tr>
<td>4-Port 10-Gigabit Ethernet Line Card</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Power Modules</td>
<td>0</td>
<td>PM0-PM5 (10-slot chassis)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>PM0-PM2 (6-slot chassis)</td>
<td></td>
</tr>
<tr>
<td>Fan controller cards</td>
<td>0</td>
<td>FC0–FC1</td>
<td></td>
</tr>
</tbody>
</table>

### Displaying Router Node IDs and Status

In administration EXEC mode, the `show platform` command displays information for all router nodes. In administration EXEC mode, the command display also includes additional node IDs such as those for fabric cards, alarm modules, and fan controllers. For each node, this information includes the host card type, the operational state, and the configuration state. To display information on a single node, enter the command with a node ID.

The syntax for the `show platform` command is:

```
show platform [node-id]
```

The following example displays the status for all nodes in the system:

```
RP/0/RSP0/CPU0:router(admin)# show platform

Sat Mar 24 05:02:18.569 DST
Node Type State Config State
------------------------------- -------------------------------
0/RSP0/CPU0 A9K-RSP-4G(Active) IOS XR RUN FWR,NSSHUT,MON
0/1/CPU0 A9K-40GE-B IOS XR RUN FWR,NSSHUT,MON
0/4/CPU0 A9K-8T/4-B IOS XR RUN FWR,NSSHUT,MON
0/6/CPU0 A9K-4T-B IOS XR RUN FWR,NSSHUT,MON
```

The `node-id` appears in the `rack/slot/module` notation, and the `node-id` components are as follows:

- **rack** — In a single-shelf system the rack number is always “0.”
- **slot** — Number of the physical slot in which the card is installed.
- **module** — Subslot number of a system hardware component.
Table 16: Node ID Components, on page 129 summarizes the node-id argument for each type of card.

Displaying Router Environment Information

The show environment command displays hardware information for the system, including fan speeds, LED indications, power supply voltage and current information, and temperatures.

The syntax for the show environment command is:

```
show environment [options]
```

You can use the show environment command options to limit the detail in the command display. To view the command options, enter the show environment ? command. The following example shows the full environment status report:

```
RP/0/RSP0/CP0:router (admin)# show environment
Mon Jun 29 04:32:07.587 PST

Temperature Information
---------------------------------------------
R/S/I Modules Inlet Hotspot
  Temperature (deg C) (deg C)
0/1/* host 31.5 39.5
0/RSP0/* host 26.6 36.6
0/4/* host 29.8 38.8
0/6/* host 32.7 42.0
0/FT0/* host 27.2 28.2
0/FT1/* host 27.4 30.2

Voltage Information
---------------------------------------------
R/S/I Modules Sensor (mV) Margin (mV) Margin
0/1/* host IBV 10647 n/a
host 5.0V 4929 n/a
host VP3P3_CAN 3288 n/a
host 3.3V 3301 n/a
host 2.5V 2516 n/a
host 1.8VB 1810 n/a
host 1.2VR 1193 n/a
host 1.8VA 1800 n/a
host 0.9VB 884 n/a
host 1.2V_LDO_BRG0 1193 n/a
```
<table>
<thead>
<tr>
<th>host</th>
<th>Value 1</th>
<th>Value 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.2V_LDO_BRG1</td>
<td>1195</td>
<td>n/a</td>
</tr>
<tr>
<td>1.8V_C</td>
<td>1811</td>
<td>n/a</td>
</tr>
<tr>
<td>1.5V_B</td>
<td>1505</td>
<td>n/a</td>
</tr>
<tr>
<td>1.5V_A</td>
<td>1503</td>
<td>n/a</td>
</tr>
<tr>
<td>1.1V_(1.05V_CPU)</td>
<td>1052</td>
<td>n/a</td>
</tr>
<tr>
<td>0.75VA</td>
<td>751</td>
<td>n/a</td>
</tr>
<tr>
<td>0.75VB_0.75VC</td>
<td>754</td>
<td>n/a</td>
</tr>
<tr>
<td>1.1VB</td>
<td>1102</td>
<td>n/a</td>
</tr>
<tr>
<td>1.2V_TCAM0</td>
<td>1003</td>
<td>n/a</td>
</tr>
<tr>
<td>1.2V_TCAM1</td>
<td>1000</td>
<td>n/a</td>
</tr>
<tr>
<td>1.0V_Bridge_LDO</td>
<td>998</td>
<td>n/a</td>
</tr>
<tr>
<td>1.0V_B</td>
<td>1043</td>
<td>n/a</td>
</tr>
<tr>
<td>0.75VD_and_0.75VE</td>
<td>752</td>
<td>n/a</td>
</tr>
<tr>
<td>1.2V_TCAM2</td>
<td>1005</td>
<td>n/a</td>
</tr>
<tr>
<td>1.2V_TCAM3</td>
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<td>n/a</td>
</tr>
<tr>
<td>1.5V_C</td>
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<td>n/a</td>
</tr>
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<td>1803</td>
<td>n/a</td>
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<td>1.1VC</td>
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<td>ZARLINK_1.8V</td>
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<td>1.2V_DB</td>
<td>1195</td>
<td>n/a</td>
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<td>3.3V_DB</td>
<td>3316</td>
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<td>IBV</td>
<td>10586</td>
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<td>Host</td>
<td>Voltage</td>
<td>Node</td>
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<tr>
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<td>1.0V_Bridge_LDO</td>
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<td>1.2VB_DB</td>
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</tbody>
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<table>
<thead>
<tr>
<th>Host</th>
<th>Voltage</th>
<th>Node</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.2V_LDO_BRG0</td>
<td>1194</td>
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</tr>
<tr>
<td>1.2V_LDO_BRG1</td>
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<td>1503</td>
<td>n/a</td>
</tr>
<tr>
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<td>n/a</td>
</tr>
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<td>0.75VA</td>
<td>752</td>
<td>n/a</td>
</tr>
<tr>
<td>0.75VB_0.75VC</td>
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</tr>
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</tr>
<tr>
<td>1.0V_Bridge_LDO</td>
<td>995</td>
<td>n/a</td>
</tr>
<tr>
<td>1.0VB</td>
<td>1050</td>
<td>n/a</td>
</tr>
<tr>
<td>0.75VD_and_0.75VE</td>
<td>752</td>
<td>n/a</td>
</tr>
<tr>
<td>1.2V_TCAM2</td>
<td>1002</td>
<td>n/a</td>
</tr>
<tr>
<td>1.2V_TCAM3</td>
<td>995</td>
<td>n/a</td>
</tr>
<tr>
<td>1.5VC</td>
<td>1502</td>
<td>n/a</td>
</tr>
<tr>
<td>1.8VD</td>
<td>1802</td>
<td>n/a</td>
</tr>
<tr>
<td>1.1VC</td>
<td>1101</td>
<td>n/a</td>
</tr>
<tr>
<td>ZARLINK_3.3V</td>
<td>3273</td>
<td>n/a</td>
</tr>
<tr>
<td>ZARLINK_1.8V</td>
<td>1804</td>
<td>n/a</td>
</tr>
<tr>
<td>1.2V_DB</td>
<td>1200</td>
<td>n/a</td>
</tr>
<tr>
<td>3.3V_DB</td>
<td>3314</td>
<td>n/a</td>
</tr>
<tr>
<td>2.5V_DB</td>
<td>2496</td>
<td>n/a</td>
</tr>
<tr>
<td>1.5V_DB</td>
<td>1496</td>
<td>n/a</td>
</tr>
<tr>
<td>1.8V_DB</td>
<td>1824</td>
<td>n/a</td>
</tr>
<tr>
<td>5.0V_XFP_DB</td>
<td>5004</td>
<td>n/a</td>
</tr>
<tr>
<td>1.2VB_DB</td>
<td>1227</td>
<td>n/a</td>
</tr>
</tbody>
</table>

LED Information
-------------------------------

<table>
<thead>
<tr>
<th>R/S/I</th>
<th>Modules LED Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>0/RSP0/*</td>
<td>Critical-Alarm Off</td>
</tr>
</tbody>
</table>
### Fan Information

<table>
<thead>
<tr>
<th>Fan speed (rpm):</th>
<th>FAN0</th>
<th>FAN1</th>
<th>FAN2</th>
<th>FAN3</th>
<th>FAN4</th>
<th>FAN5</th>
<th>FAN6</th>
<th>FAN7</th>
<th>FAN8</th>
<th>FAN9</th>
</tr>
</thead>
<tbody>
<tr>
<td>FAN10/FAN11</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0/FT0/*</td>
<td>3510</td>
<td>3510</td>
<td>3510</td>
<td>3540</td>
<td>3510</td>
<td>3570</td>
<td>3480</td>
<td>3570</td>
<td>3510</td>
<td>3510</td>
</tr>
<tr>
<td>3510</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0/FT1/*</td>
<td>3540</td>
<td>3510</td>
<td>3450</td>
<td>3540</td>
<td>3480</td>
<td>3600</td>
<td>3480</td>
<td>3450</td>
<td>3540</td>
<td>3540</td>
</tr>
<tr>
<td>3480</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Power Supply Information

<table>
<thead>
<tr>
<th>R/S/I Modules Sensor Watts</th>
</tr>
</thead>
<tbody>
<tr>
<td>0/PM0/* host PM 3000</td>
</tr>
<tr>
<td>0/PM1/* host PM 3000</td>
</tr>
<tr>
<td>0/PM2/* host PM 3000</td>
</tr>
</tbody>
</table>

Power Shelves Type: AC

- Total Power Capacity: 9000W
- Protected Power Capacity: 4500W
- Worst Case Power Used: 3145W

<table>
<thead>
<tr>
<th>Slot</th>
<th>Max Watts</th>
</tr>
</thead>
<tbody>
<tr>
<td>0/1/CPU0</td>
<td>375</td>
</tr>
<tr>
<td>0/RSP0/CPU0</td>
<td>250</td>
</tr>
<tr>
<td>0/RSP1/CPU0</td>
<td>350</td>
</tr>
<tr>
<td>0/4/CPU0</td>
<td>375</td>
</tr>
<tr>
<td>0/6/CPU0</td>
<td>375</td>
</tr>
<tr>
<td>0/FT0/SP</td>
<td>710 (default)</td>
</tr>
<tr>
<td>0/FT1/SP</td>
<td>710 (default)</td>
</tr>
</tbody>
</table>

Worst Case Protected Power Available: 1355W

## Configuring the Chassis Altitude

To allow your router to adjust the fan speed to compensate for lower cooling capabilities at higher altitudes, you should configure the chassis altitude setting. Use the `environment altitude` command in administration configuration mode. The default setting is 1800 meters.

The syntax for the environment altitude command is:

```
environment altitude altitude rack rack-no
```
Displaying RP Redundancy Status

The **show redundancy** command displays the redundancy status of the route switch processors (RSPs). This command also displays the boot and switch-over history for the RSPs.

The **show redundancy** operates in EXEC and administration EXEC mode.

In the following example, the **show redundancy** command displays the redundancy status for a redundant RSP pair:

```
RP/0/RSP0/CPU0:router (admin) # show redundancy
Mon Jun 29 04:49:26.098 PST
Redundancy information for node 0/RSP0/CPU0:
==========================================
Node 0/RSP0/CPU0 is in ACTIVE role
Node 0/RSP0/CPU0 has no valid partner
Reload and boot info
----------------------
A9K-RSP-4G reloaded Thu Jun 11 15:20:50 2009: 2 weeks, 3 days, 13 hours, 28 minutes ago
Active node booted Thu Jun 11 15:20:50 2009: 2 weeks, 3 days, 13 hours, 28 minutes ago
Active node reload "Cause: Turboboost completed successfully"
```

Displaying Field-Programmable Device Compatibility

The **show hw-module fpd** command displays field-programmable device (FPD) compatibility for all modules or a specific module.

The syntax for the **show hw-module fpd** command is:

```
show hw-module fpd location {all | node-id}
```

The **show hw-module fpd** operates in EXEC and administration EXEC mode.

The following example shows how to display FPD compatibility for all modules in the router:

```
RP/0/RSP0/CPU0:router # show hw-module fpd location all
===================================== =========================================
Existing Field Programmable Devices
-------------------------------------------
Location | Card Type          | HW Current SW Upg/ | Type   | Subtype   | Inst | Version     | Dng?
-------------------------------------------
0/RSP0/CPU0 | A9K-RSP-4G | 1.0 | lc | fpga3 | 0 | 1.23 | Yes
fpga1 | 0 | 1.05 | No
fpga2 | 0 | 3.08^ | No
--------------------------------------------------------------------------------
0/0/0 | SPA-2XCHOC12/DS0 | 1.0 | spa | rommon | 0 | 2.02 | No
spa | fpga | 0 | 1.36+ | No
spa | fpga2 | 0 | 1.00* | No
--------------------------------------------------------------------------------
```

**NOTES:**
1. One or more FPD needs an upgrade or a downgrade. This can be accomplished using the "admin upgrade hw-module fpd" CLI.
2. * One or more FPD is running minimum software version supported.
   It can be upgraded using the "admin> upgrade hw-module fpd <fpd> force location <loc>"
The following example shows the FPD for which upgrade will be skipped.

```
RP/0/RP0/CP00:router# show hw-module fpd location all
```

<table>
<thead>
<tr>
<th>Location</th>
<th>Card Type</th>
<th>HW</th>
<th>Current SW</th>
<th>Upg/Dng?</th>
</tr>
</thead>
<tbody>
<tr>
<td>0/SM1/SP</td>
<td>140G-4-S1S2S3</td>
<td>0.1 lc</td>
<td>rommonA</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>1c rommon</td>
<td>0</td>
<td>2.08</td>
</tr>
<tr>
<td></td>
<td></td>
<td>lc fpga1</td>
<td>0</td>
<td>6.04*</td>
</tr>
</tbody>
</table>

**NOTES:**
1. ^ One or more FPD will be intentionally skipped from upgrade using CLI with option "all" or during "Auto fpd". It can be upgraded only using the "admin> upgrade hw-module fpd <fpd> location <loc>" CLI with exact location.

**BPID nodes can be used as location to display the BPID image information:**

```
RP/0/RSP0/CP00:router# sh hw-module fpd location 0/bpid0/sp
```

<table>
<thead>
<tr>
<th>Location</th>
<th>Card Type</th>
<th>HW</th>
<th>Current SW</th>
<th>Upg/Dng?</th>
</tr>
</thead>
<tbody>
<tr>
<td>0/BPID0/SP</td>
<td>ASR-9912-BPID2</td>
<td>1.0 bp</td>
<td>cbc</td>
<td>11</td>
</tr>
</tbody>
</table>

**The following example shows how to display FPD compatibility for a specific module in the router:**

```
RP/0/RSP1/CP00:router# show hw-module fpd location 0/4/cpu0
```

**After Release 5.3.x, Upg/Dng? will display Yes only for upgrade.**
Table 17: show hw-module fpd Field Descriptions

<table>
<thead>
<tr>
<th>Field</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location</td>
<td>Location of the module in the rack/slot/module notation.</td>
</tr>
<tr>
<td>Card Type</td>
<td>Module part number.</td>
</tr>
<tr>
<td>HW Version</td>
<td>Hardware model version for the module.</td>
</tr>
<tr>
<td>Type</td>
<td>Hardware type. Can be one of the following types:</td>
</tr>
<tr>
<td></td>
<td>• spa—Shared port adapter</td>
</tr>
<tr>
<td></td>
<td>• lc—Line card</td>
</tr>
<tr>
<td>Subtype</td>
<td>FPD type. Can be one of the following types:</td>
</tr>
<tr>
<td></td>
<td>• fabldr—Fabric downloader</td>
</tr>
<tr>
<td></td>
<td>• fpga1—Field-programmable gate array</td>
</tr>
<tr>
<td></td>
<td>• fpga2—Field-programmable gate array 2</td>
</tr>
<tr>
<td></td>
<td>• fpga3—Field-programmable gate array 3</td>
</tr>
<tr>
<td></td>
<td>• fpga4—Field-programmable gate array 4</td>
</tr>
<tr>
<td></td>
<td>• fpga5—Field-programmable gate array 5</td>
</tr>
<tr>
<td></td>
<td>• rommonA—Read-only memory monitor A</td>
</tr>
<tr>
<td></td>
<td>• rommon—Read-only memory monitor B</td>
</tr>
<tr>
<td>Inst</td>
<td>FPD instance. The FPD instance uniquely identifies an FPD and is used by the FPD process to register an FPD.</td>
</tr>
<tr>
<td>Current SW Version</td>
<td>Currently running FPD image version.</td>
</tr>
<tr>
<td>Upg/Dng?</td>
<td>Specifies whether an FPD upgrade or downgrade is required. A downgrade is required in rare cases when the version of the FPD image has a higher major revision than the version of the FPD image in the current Cisco IOS XR software package.</td>
</tr>
</tbody>
</table>

RSP Redundancy and Switchover

This section describes RSP redundancy and switchover commands and issues.
Establishing RSP Redundancy

Your router has two slots for RSPs: RSP0 and RSP1 (see Figure 6: Redundant Set of RSPs Installed in Slots RSP0 and RSP1 in an 8-Slot Chassis, on page 137). RSP0 is the slot on the left, facing the front of the chassis, and RSP1 is the slot on right. These slots are configured for redundancy by default, and the redundancy cannot be eliminated. To establish RSP redundancy, install RSPs into both slots.

Figure 6: Redundant Set of RSPs Installed in Slots RSP0 and RSP1 in an 8-Slot Chassis

Determining the Active RP in a Redundant Pair

During system startup, one RSP in each redundant pair becomes the active RSP. You can tell which RSP is the active RSP in the following ways:

- The active RSP can be identified by the green Primary LED on the faceplate of the card. The active RSP is indicated when the Primary LED is on. The alphanumeric LED display on the RSP displays ACTV RP.
- The slot of the active RSP is indicated in the CLI prompt. For example:

  RP/0/RSP1/CPU0:router#

In this example, the prompt indicates that you are communicating with the active RSP in slot RSP1. See Cisco ASR 9000 Series Aggregation Services Router Getting Started Guide for a complete description of the CLI prompt.
Enter the `show redundancy` command in EXEC mode to display a summary of the active and standby RSP status. For example:

```
RP/0/RSP0/CPU0:router(admin)# show redundancy
```

```
Mon Jun 29 04:49:26.098 PST
Redundancy information for node 0/RSP0/CPU0:
==========================================
Node 0/RSP0/CPU0 is in ACTIVE role
Node 0/RSP0/CPU0 has no valid partner
Reload and boot info
----------------------
A9K-RSP-4G reloaded Thu Jun 11 15:20:50 2009: 2 weeks, 3 days, 13 hours, 28 minutes ago
Active node booted Thu Jun 11 15:20:50 2009: 2 weeks, 3 days, 13 hours, 28 minutes ago
Active node reload "Cause: Turboboot completed successfully"
```

### Role of the Standby RSP

The second RSP to boot in a redundant pair automatically becomes the standby RSP. While the active RSP manages the system and communicates with the user interface, the standby RSP maintains a complete backup of the software and configurations for all cards in the system. If the active RSP fails or goes off line for any reason, the standby RSP immediately takes control of the system.

### Summary of Redundancy Commands

RSP redundancy is enabled by default in the Cisco IOS XR software, but you can use the commands described in Table 18: RSP Redundancy Commands, on page 138 to display the redundancy status of the cards or force a manual switchover.

#### Table 18: RSP Redundancy Commands

<table>
<thead>
<tr>
<th>Command</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>show redundancy</code></td>
<td>Displays the redundancy status of the RSPs. This command also displays the boot and switch-over history for the RSPs.</td>
</tr>
<tr>
<td><code>redundancy switchover</code></td>
<td>Forces a manual switchover to the standby RSP. This command works only if the standby RSP is installed and in the “ready” state.</td>
</tr>
<tr>
<td><code>show platform</code></td>
<td>Displays the status for node, including the redundancy status of the RSP cards. In EXEC mode, this command displays status for the nodes assigned to the SDR. In administration EXEC mode, this command displays status for all nodes in the system.</td>
</tr>
</tbody>
</table>

### Automatic Switchover

Automatic switchover from the active RSP to the standby RSP occurs only if the active RSP encounters a serious system error, such as the loss of a mandatory process or a hardware failure. When an automatic switchover occurs, the RSPs respond as follows:
• If a standby RSP is installed and “ready” for switchover, the standby RSP becomes the active RSP. The original active RSP attempts to reboot.
• If the standby RSP is not in “ready” state, then both RSPs reboot. The first RSP to boot successfully assumes the role of active RSP.

**RSP Redundancy During RSP Reload**

The `reload` command causes the active RSP to reload the Cisco IOS XR software. When an RSP reload occurs, the RSPs respond as follows:

• If a standby RSP is installed and “ready” for switchover, the standby RSP becomes the active RSP. The original active RSP reboots and becomes the standby RSP.
• If the standby RSP is not in the “ready” state, then both RSPs reboot. The first RSP to boot successfully assumes the role of active RSP.

**Caution**

You should not use the `reload` command to force an RSP switchover because the result could be a significant loss of router operations. Instead, use the `redundancy switchover` command to fail over to the standby RSP, then use the `hw-module location node-id reload` command to reload the new standby RSP.

**Related Topics**

Reloading, Shutting Down, or Power Cycling a Node, on page 146

**Manual Switchover**

You can force a manual switchover from the active RSP to the standby RSP using the `redundancy switchover` command.

If a standby RSP is installed and ready for switchover, the standby RSP becomes the active RSP. The original active RSP becomes the standby RSP. In the following example, partial output for a successful redundancy switchover operation is shown:

```
RP/0/RSP0/CPU0:router# show redundancy
This node (0/RSP0/CPU0) is in ACTIVE role
Partner node (0/RSP1/CPU0) is in STANDBY role
Standby node in 0/RSP1/CPU0 is ready
RP/0/RSP0/CPU0:router# redundancy switchover
Updating Commit Database. Please wait...[OK]
Proceed with switchover 0/RSP0/CPU0 -> 0/RSP1/CPU0? [confirm]
Initiating switch-over.
RP/0/RSP0/CPU0:router#

<Your 'TELNET' connection has terminated>
```

In the preceding example, the Telnet connection is lost when the previously active RP resets. To continue management of the router, you must connect to the newly activated RP as shown in the following example:

```
User Access Verification

Username: xxxxxx
```
If the standby RSP is not in “ready” state, the switchover operation is not allowed. In the following example, partial output for a failed redundancy switchover attempt is shown:

```
RP/0/RSP0/CPU0:router# show redundancy

Redundancy information for node 0/RP1/CPU0:
==========================================
Node 0/RSP0/CPU0 is in ACTIVE role
Partner node (0/RSP1/CPU0) is in UNKNOWN role

Reload and boot info
-------------------
RP reloaded Wed Mar 29 17:22:08 2009: 2 weeks, 2 days, 19 hours, 14 minutes ago
Active node booted Sat Apr 15 12:27:58 2009: 8 minutes ago
Last switch-over Sat Apr 15 12:35:42 2009: 1 minute ago
There have been 4 switch-overs since reload

RP/0/RSP0/CPU0:router# redundancy switchover

Switchover disallowed: Standby node is not ready.
```

**Communicating with a Standby RP**

The active RSP automatically synchronizes all system software, settings, and configurations with the standby RSP.

If you connect to the standby RSP through the console port, you can view the status messages for the standby RSP. The standby RSP does not display a CLI prompt, so you cannot manage the standby card while it is in standby mode.

If you connect to the standby RSP through the management Ethernet port, the prompt that appears is for the active RSP, and you can manage the router the same as if you had connected through the management Ethernet port on the active RSP.

**Console Management Port**

The Console Management Port (CMP) feature enables console access to the RSP and RP network devices through an ethernet port on the router using the Secure Shell (SSH).

To enable CMP feature the IPU and ROMMON must be upgraded to the latest version available in the Cisco IOS XR Software Release 5.3.2 through FPD upgrade for IOS XR 32-bit image.

For information about FPD upgrade, see *Cisco ASR 9000 Series Aggregation Services Router System Management Configuration Guide*, chapter Upgrading FPD.
The CMP feature enables:

- ROMMON and XR access.
- Connection to route processor console port.
- Connection to route processor auxiliary port (32-bit image) or system admin plane (64-bit image).
- Installation of new software image through SCP (32-bit image) or PXE (64-bit image) without a terminal server connected to the console port.
- CMP password recovery by using the `resetcmp` command on the CMP shell. This clears CMP data (user IDs, passwords, DNS name, hostname, SSH Key) to default settings.

The default login username is `cmp` and password is `cisco123`.

You can download a new Cisco IOS XR image using the `tftp` or `scp` command. You must provide the server IPv6 address and filename when using `scpboot` command. The image is copied from the server directly to the route processor CPU memory. If route processor CPU side is in ROMMON or already in IOS XR, it is reset and held in ROMMON until the image is copied. This image is automatically booted (turbo boot for 32-bit) on the route processor CPU side. The image download options provided by the CMP can only download and boot a complete image. Subsequent image upgrades, pie downloads (32-bit image) must be done through system admin (32-bit image), and using the management ports.

CMP implements zero-configuration networking concepts such as mDNS and DNS-SD to ease the booting of a supervisor (RSP, RP) card. See the section Zero Configuration Networking, on page 143 for information on zero-configuration networking.

For information on CMP shell, see the section CMP Shell, on page 141.

**CMP Shell**

CMP is accessed using IPv6 SSH. Use the default username/password to login to CMP shell. This table describes the commands available on the CMP shell:

<table>
<thead>
<tr>
<th>Command</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>adduser</code></td>
<td>Adds a new CMP user ID/password.</td>
</tr>
<tr>
<td><code>aux</code></td>
<td>Connects to route processor CPU auxiliary port for 32-bit image.</td>
</tr>
<tr>
<td>Command</td>
<td>Description</td>
</tr>
<tr>
<td>----------</td>
<td>-------------</td>
</tr>
<tr>
<td>con</td>
<td>Connects to route processor CPU console port. Although multiple SSH sessions to the CMP shell are allowed, the con, aux, or lc command execution is allowed for only single user at a time.</td>
</tr>
<tr>
<td>copykey</td>
<td>SCP a key.</td>
</tr>
<tr>
<td>deluser</td>
<td>Deletes a user ID. It is recommended that you delete the default username cmp after a new user is created.</td>
</tr>
<tr>
<td>desc_err</td>
<td>Shows description of command error codes.</td>
</tr>
<tr>
<td>debug</td>
<td>Enables CMP console logging functionality.</td>
</tr>
<tr>
<td>dns</td>
<td>Changes DNS name. The initial service advertisement uses the domain name of chassis serial number + RSP/RP slot. This can be changed using the dns command.</td>
</tr>
<tr>
<td>exit</td>
<td>Logs out of CMP.</td>
</tr>
<tr>
<td>fanspeed</td>
<td>Shows information about fan trays in the chassis.</td>
</tr>
<tr>
<td>help</td>
<td>Displays available CMP commands.</td>
</tr>
<tr>
<td>hostname</td>
<td>Changes a host name.</td>
</tr>
<tr>
<td>lc</td>
<td>Connects to a line card console.</td>
</tr>
<tr>
<td>lcslotinfo</td>
<td>Shows line card slot ID information.</td>
</tr>
<tr>
<td>passwd</td>
<td>Changes password (minimum 5 and maximum 8 characters).</td>
</tr>
<tr>
<td>power</td>
<td>[cycle] [off] [on] &lt;slot&gt; Powers on/off card</td>
</tr>
<tr>
<td>priv</td>
<td>Enters privileged EXEC mode.</td>
</tr>
<tr>
<td>tftp</td>
<td>TFTP boots Cisco IOS XR image to Route processor CPU memory.</td>
</tr>
<tr>
<td>resetcmp</td>
<td>Clears CMP data (user IDs, passwords, DNS name, hostname and SSH key) to default settings.</td>
</tr>
<tr>
<td>run</td>
<td>Runs diagnostic commands ping/ping6/traceroute/traceroute6 to diagnose basic network connectivity problems.</td>
</tr>
<tr>
<td>scp</td>
<td>SCP boots 32-bit IOS XR image.</td>
</tr>
</tbody>
</table>
### Command

<table>
<thead>
<tr>
<th>Command</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>show</strong></td>
<td>Shows all CMP data.</td>
</tr>
<tr>
<td></td>
<td>Displays ip/key/cmp configuration.</td>
</tr>
<tr>
<td><strong>showinv</strong></td>
<td>Shows the physical inventory.</td>
</tr>
<tr>
<td><strong>showtemp</strong></td>
<td>Shows the temperature information.</td>
</tr>
<tr>
<td><strong>slotmap</strong></td>
<td>Displays physical slot and card mapping information.</td>
</tr>
<tr>
<td><strong>sshkeygen</strong></td>
<td>Generates a new SSH key.</td>
</tr>
<tr>
<td><strong>unlock</strong></td>
<td>Removes all system locks.</td>
</tr>
<tr>
<td></td>
<td>From CMP shell only one user is allowed to login to the console port, auxiliary port or LC console, and that user holds the lock and there is no access to other users.</td>
</tr>
<tr>
<td><strong>reset</strong></td>
<td>Enables a router to warm-reboot.</td>
</tr>
</tbody>
</table>

Return Material Authorization (RMA) - In the event of a RMA of the supervisor (RSP/RP) card, since the CMP information is tied to the chassis serial number, all the modified information using the CMP shell is reverted back to factory default values. This means that the username/password database would be erased and the default username/password is in effect. The domain name used in service advertisement reverts to the chassis serial number plus slot ID.

### Limitations

These are the limitation of CMP:

- CMP supports only SSH service.
- Only one SSH session has console, auxiliary or system admin port.
- CMP does not support software image upgrade, pie or VM downloads.
- IPv6 link local address is preferred by Avahi application rather than the IPv6 global address.
- There is no authentication performed on users logging into the CMP shell.
- Warm reload causes loss of CMP SSH session only in A9K-RSP880-TR/SE or A99-RP2-TR/SE.

### Zero Configuration Networking

CMP configures the network devices using zero-configuration networking model and eliminates the need to have serial terminal servers. The zero-configuration networking enables:

- automatic IP address selection for network device—If a network device does not have an IP address assigned to it, then zero-configuration networking supports DHCP to obtain IPv6 Stateless Address Autoconfiguration (SLAAC), IPv4 and IPv6 addresses. The CMP port when connected to a IPv6 network obtains a link local address and also IPv6 global auto address based on IPv6 SLAAC.
• automatic domain name resolution and distribution of computer host names—The zero-configuration networking implements multicast DNS (mDNS). mDNS allows a network device to select a domain name in the local namespace and then broadcast that name using a special multicast IP address, allowing other devices on the network to connect to it by name instead of by numbered IP address. This eliminates the need to configure a DNS server.

• automatic location of network services through DNS service discovery—The zero-configuration networking enables a network device to use standard DNS queries to discover devices registered on the network that are broadcasting the services that they provide. This eliminates the need to set up a directory server.

These are the zero-configuration networking applications that are supported:

• For Windows and MAC OS—Bonjour

• For Linux OS—Avahi

CPAKs are the Cisco's innovation for 100G pluggable optics, which is built with the industry leading smallest form factor, in full compliant with IEEE802.3ae specification for 100GE-SR10, -LR4, and can interoperate with all IEEE 802.3ba compliant CFP-SR10 or CFP-LR4 100G optics.

The key new functionality is that CPAK variants are being constructed that represent 10 x 10GE ports. A single physical port on the linecard needs to instantiate multiple breakout Ethernet interfaces, very much similar to serial interface channelization.

Modes supported on CPAKs

This table clearly lists the modes supported with the relevant PID:

<table>
<thead>
<tr>
<th>CPAK (PID)</th>
<th>Modes Supported</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPAK-100G-SR10</td>
<td>100 GE, 10 GE, 40 GE</td>
</tr>
<tr>
<td>CPAK-100G-LR</td>
<td>100 GE</td>
</tr>
<tr>
<td>CPAK-10X10G-LR</td>
<td>10 GE</td>
</tr>
</tbody>
</table>

The standard R/S/I/P format is 4-tuple. 5-tuple interfaces are represented as - R/S/I/P/SP. P is the CPAK port and SP indicates the breakout port. A CPAK which is configured as 5 tuple after executing the breakout command can be configured as 0x10G configuration. A CPAK, without the breakout mode can only be configured as 100G, represents a 4 tuple configuration. The default interface type is HundredGigE. If there is no configuration then Hundred GigE interface would be created for the CPAK ports.

Configuring Breakout

This task enables the user to configure the breakout option.

SUMMARY STEPS

1. configure
2. hw-module location preconfigure location port breakout interface

DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> configure</td>
<td>Configure the breakout option.</td>
</tr>
<tr>
<td><strong>Step 2</strong> hw-module location preconfigure location port breakout interface</td>
<td>The optional keyword, <strong>preconfigure</strong> enables the user to preconfigure breakout on an empty slot. SR10 CPAK can operate in the following modes - 1x100GE or 10x10GE. 1x100GE is the default option. 10x10 CPAK can also support 10x10GE.</td>
</tr>
</tbody>
</table>

**Purpose**

Configure the breakout option.

**Note**

Example:

```
RP/0/RSP0/CPU0:router (config) # hw-module location 0/0/CPU0 port 0 breakout 10x TenGigE
```

**Power saving mode**

8x100GE Line card consists of 4 Slices (0,1,2,3). Each slice has two physical ports. Slice-1, 2 and 3 can be configured into power save mode. Power save option is not applicable to Slice-0. Use the **hw-module power saving** command to configure the required slice to power saving mode.

Once a slice is configured in the power saving mode, the interfaces will be deleted and hence all traffic passing through the interfaces will be dropped.

<table>
<thead>
<tr>
<th>Table 20: Slice-Port mapping table</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slice 1</td>
</tr>
<tr>
<td>Slice 2</td>
</tr>
<tr>
<td>Slice 3</td>
</tr>
</tbody>
</table>

**To configure the power save option**

This task enables the user to configure the power save option.

**SUMMARY STEPS**

1. admin
2. configure
3. hw-module power saving location location slice number

DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> admin</td>
<td>Enters administration EXEC mode.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
</tbody>
</table>
### Step 2

**Command:**

```
configure
```

**Purpose:**

Configures the power saving option for the specified slice.

The available options are Slice 1, 2, 3.

### Step 3

**Command:**

```
hw-module power saving location location slice number
```

**Example:**

```
RP/0/RSP0/CPU0:router (admin-config) # hw-module
power saving location 0/1/CPU0 slice 3
```

**Note:**

Power save option is not applicable for Slice 0.

---

**What to do next**

Use the `show plat slices` command to get the status of the slices.

---

### Reloading, Shutting Down, or Power Cycling a Node

Use the commands described in this section to reload the Cisco IOS XR software on the active RSP or on any specified node in the system. This section also describes the commands used to administratively shut down a node and power a node on or off.

**Table 21: Commands to Reload, Shut Down, or Power Cycle a Node, on page 146** summarizes the commands described in this section.

**Table 21: Commands to Reload, Shut Down, or Power Cycle a Node**

<table>
<thead>
<tr>
<th>Command</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>hw-module location node-id power disable</code></td>
<td>This command administratively turns the power off for a node. It is entered in administration configuration mode. The changes do not take effect until you enter the <code>commit</code> command. To power on a node, use the <code>no</code> form of this command. <strong>Note</strong> This command cannot be used to disable power on the RSP from which the command is entered.</td>
</tr>
<tr>
<td><code>hw-module location node-id reload</code></td>
<td>This command works in EXEC mode and reloads the Cisco IOS XR software on a specific node or all nodes. To specify all nodes, enter the <code>all</code> keyword in place of the <code>node-id</code> argument. The node reloads with the current running configuration and active software set for that node.</td>
</tr>
<tr>
<td><code>hw-module shutdown location node-id</code></td>
<td>This command must be entered in administration configuration mode and administratively shuts down the specified node. Nodes that are shut down still have power but cannot load or operate Cisco IOS XR software. To return a node to the up state, use the <code>no</code> form of this command. <strong>Note</strong> This command cannot be used to shut down the RSP from which the command is entered.</td>
</tr>
</tbody>
</table>
## Reloading the Active RSP

The `reload` command causes the active RSP to reload the Cisco IOS XR software according to the configuration register setting. This setting determines how the active RSP acts when reloaded.

This section contains instructions to reload the Cisco IOS XR software and return to EXEC mode. For instructions to use the `reload` command for entering ROM Monitor bootstrap mode, see *ROM Monitor Configuration Guide for Cisco ASR 9000 Routers*.

---

**Caution**

Because the `reload` command causes the active RSP to go off line and either reload the Cisco IOS XR software or enter ROM Monitor mode, the router experiences a loss of service unless a redundant standby RSP is installed and in “ready” state. To display the status of the standby RSP, use the `show redundancy` command in EXEC mode.

---

### SUMMARY STEPS

1. `show redundancy`
2. `admin`
3. `show variables boot`
4. (Optional) `config-register register-value`
5. `admin`
6. `reload`

### DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td>Displays the RSP redundancy status.</td>
</tr>
<tr>
<td>show redundancy</td>
<td>• If a standby RSP is in “ready” redundancy state, the <code>reload</code> command also causes the router to gracefully fail over to the standby RSP.</td>
</tr>
<tr>
<td>Example:</td>
<td><img src="image2.png" alt="Image" /></td>
</tr>
<tr>
<td>RP/0/RSP0/CPU0:router# show redundancy</td>
<td><img src="image3.png" alt="Image" /></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Step 2</th>
<th><code>admin</code></th>
<th>Enters administration EXEC mode.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Example:</td>
<td>RP/0/RSP0/CPU0:router# admin</td>
<td><img src="image4.png" alt="Image" /></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Step 3</th>
<th><code>show variables boot</code></th>
<th>Displays the configuration register setting.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Example:</td>
<td>RP/0/RSP0/CPU0:router(admin)# show variables boot</td>
<td><img src="image5.png" alt="Image" /></td>
</tr>
<tr>
<td><img src="image6.png" alt="Image" /></td>
<td><img src="image7.png" alt="Image" /></td>
<td><img src="image8.png" alt="Image" /></td>
</tr>
</tbody>
</table>
### Flash Disk Recovery

When an RSP is power cycled or experiences an ungraceful reset, the boot disk (PCMCIA flash disk used to boot the card) may experience a file-system corruption. If this occurs, an error message is displayed and the RSP fails to boot. The corrupted flash disk is automatically reformatted and the Cisco IOS XR software is restored from the designated system controller (DSC) for the system.

For example, if a flash disk for an RSP is corrupted, the RP fails to boot and the following error message is displayed:

```
#########################################################
Restricted Rights Legend
Use, duplication, or disclosure by the Government is
subject to restrictions as set forth in subparagraph
(c) of the Commercial Computer Software - Restricted
Rights clause at FAR sec. 52.227-19 and subparagraph
(c) (1) (ii) of the Rights in Technical Data and Computer
Software clause at DFARS sec. 252.227-7013.

cisco Systems, Inc.
170 West Tasman Drive
San Jose, California 95134-1706
#########################################################
```
Unable to mount /disk0:, filesystem is corrupted.
Check fsck log at /tmp/chkfs_fd0.log
init: special_commands:wait_for_disk0: failed

If this occurs, then the flash disk is automatically reformatted and the Cisco IOS XR software is restored to the flash disk.

---

**Note**

If the flash disk is badly damaged and cannot be reformatted, the disk must be replaced.

If the corrupted flash disk is the DSC, then the router fails over to the standby DSC. If no standby DSC is installed, then the system fails to boot.

---

## Using Controller Commands to Manage Hardware Components

The `controller`, `controllers`, and `show controllers` commands are used to manage and display settings for various hardware components, including the switch fabric management, Ethernet control plane, and interface manager. These commands are primarily diagnostic and related to driver-level details. The information available with these commands varies widely and is hardware specific.

For information on the use of these commands, see *Interface and Hardware Component Command Reference for Cisco ASR 9000 Series Routers*.

## Formatting Hard Drives, Flash Drives, and Other Storage Devices

To format a storage device on the router, use the `format` command in EXEC mode.

---

**Caution**

Formatting a storage device deletes all data on that device.

The following command syntax is used:

```plaintext
format filesystem: [options]
```

Table 22: `format` command Syntax Description, on page 150 describes the `format` command syntax.
Table 22: format command Syntax Description

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>filesystem</td>
<td>Specifies the memory device to format. The supported file systems are:</td>
</tr>
<tr>
<td></td>
<td>• bootflash:</td>
</tr>
<tr>
<td></td>
<td>• compactflash:</td>
</tr>
<tr>
<td></td>
<td>• configflash:</td>
</tr>
<tr>
<td></td>
<td>• harddisk:</td>
</tr>
<tr>
<td></td>
<td>• harddiska:</td>
</tr>
<tr>
<td></td>
<td>• disk0:</td>
</tr>
<tr>
<td></td>
<td>• disk1:</td>
</tr>
<tr>
<td></td>
<td>Enter format ? to see the devices supported on your router.</td>
</tr>
<tr>
<td>options</td>
<td>Enter format filesystem: ? to see the available options.</td>
</tr>
<tr>
<td></td>
<td>For more information, see System Management Command Reference for Cisco ASR 9000 Series Routers.</td>
</tr>
</tbody>
</table>

In the following example, the format command is used to format the hard disk:

```
RP/0/RSP0/CPU0:router# format harddisk:
```

## Removing and Replacing Cards

This section describes card replacement issues and procedures.

### Removing Line Cards

Line cards are designed for online insertion and removal (OIR). A line card is a single card that contains all service processing functions and physical line interfaces.

The OIR feature allows you to remove and replace cards without removing power to the card or chassis. Removing a card interrupts all traffic passing through the card, but it does not remove the card configuration.

When you remove a card, the configuration remains for all interfaces, but the interfaces do not appear in the output of the show interfaces command. You can view interface configurations by entering the show running-config command. The following example shows how the configuration appears when a card is removed:

```
RP/0/RSP0/CPU0:router# show running-config

Building configuration...
hostname router
router ospf 3269
  area 0
    interface POS0/3/0/0
        cost 20
    !
    interface preconfigure POS0/3/0/0
```
ipv4 address 10.10.50.1 255.255.255.0
!
interface preconfigure POS0/3/0/1
description POS0/3/0/1
shutdown
!
interface preconfigure POS0/3/0/2
description POS0/3/0/2
shutdown
!
interface preconfigure POS0/3/0/3
description POS0/3/0/3
shutdown
!

In this example, the line card in slot 3 is removed, and the interface configuration for all four interfaces changes to “interface preconfigure.” However, the “router ospf” reference to a slot 3 interface does not change. If you replace a line card with another line card that uses the same media type and port count, the configuration becomes active on the replacement card.

To remove the configuration for a slot after a card is removed, use the no interface preconfigure command to remove all interface configuration statements for that card in the running configuration. In addition, search the configuration for any references to the removed interfaces, such as the “router ospf” reference to slot 3 in the preceding example.

To remove the configuration for a slot when a card is installed, use the no interface command to remove all interface configuration statements for that card in the running configuration. In addition, search the configuration for any references to the removed interfaces.

Each line card supports a specific media type (Packet over SONET/SDH [POS] or Ethernet, for example) and port count. If you replace a line card with one that supports a different media type or port count, you should review the configuration and revise it to support the replacement line card.

**Replacing a Line Card with the Same Media Type and Port Count**

When you replace a line card or PLIM with a card that is of the same media type and has the same port count as the replaced card, the guidelines in the Removing Line Cards, on page 150 apply. Because the replacement card is of the same media type and port count, no special procedures are required for card removal and replacement.

**Replacing a Line Card with the Same Media Type and a Different Port Count**

When you replace a line card with a card that is of the same media type with a different port count, the guidelines in Removing Line Cards, on page 150 apply.

If the new card has a greater port count than the replaced card, the configuration applies to the corresponding lower port numbers, and the ports that did not exist on the replaced card have no configuration and come up in the shutdown state.

If the new card supports fewer ports, the existing configuration for the corresponding number of ports on the new card set is applied. The previous configuration for the removed ports remains in interface preconfigure state, as shown in the following example:

```
RP/0/RSP0/CPU0:router# show running-config
Building configuration...
```
hostname rtp-gsr1
interface POS0/3/0/0
  ipv4 address 10.10.50.1 255.255.255.0
!
interface preconfigure POS0/3/0/1
  description POS0/3/0/1
  shutdown
!
interface preconfigure POS0/3/0/2
  description POS0/3/0/2
  shutdown
!
interface preconfigure POS0/3/0/3
  description POS0/3/0/3
  shutdown
!

In the preceding example, a four-port card has been replaced with a single-port card. The configuration from port 1 on the four-port card is applied to the single port on the replacement card, and the remaining port configurations change to “interface preconfigure.” To remove the configuration for the missing interfaces, use the no interface preconfigure command. In addition, search for and remove any configuration references to the removed interfaces.

Whenever you replace a line card with the same media type and a different port count, review the running configuration in the router and revise the configuration as necessary.

### Replacing a Line Card or PLIM with a Different Media Type

When you replace a line card or PLIM with a card that is of a different media type (for example, if you replace a POS PLIM with an Ethernet PLIM), the guidelines in Removing Line Cards, on page 150 apply. Review the running configuration in the router and revise the configuration as necessary for the new media type.

### Examples: Breakout and Power saving options

The following are the examples for the power save and breakout options:

**Power saving mode**

Configuring the power saving option:

```
admin
  config
    hw-module power saving location 0/0/CPU0 slice 3

  show platform slices
  Line Card   Slice   Config   Status
  0/0/CPU0    0       Power on    Completed
  1           Power on    Completed
  2           Power on    Completed
  3           Power saving Completed
```

**Breakout option**

Configuring the breakout option:

```
config
  hw-module location 0/0/CPU0 port 0 breakout 10xTenGigE
```
show command output indicating the breakout ports:

```
RP/0/RSP0/CPU0:TD02#show ipv4 interface brief | include Hun
Sun Sep  7 15:59:33.446 PST
HundredGigE0/0/0/0  34.34.34.2  Down  Down
HundredGigE0/0/0/1  100.0.1.1   Up    Up
HundredGigE0/0/0/2  unassigned Up    Up
HundredGigE0/0/0/3  unassigned Up    Up
HundredGigE0/0/0/4  unassigned Shutdown Down
HundredGigE0/0/0/5  unassigned Shutdown Down
HundredGigE0/0/0/6  unassigned Shutdown Down
HundredGigE0/0/0/7  unassigned Shutdown Down
```

```
RP/0/RSP0/CPU0:router(config)#hw-module location 0/0/CPU0 port 2 breakout 10xTenGigE
RP/0/RSP0/CPU0:router(config)#commit
```

```
RP/0/RSP0/CPU0:router(config)# hw-module location 0/0/CPU0 port 2 breakout 10xTenGigE
RP/0/RSP0/CPU0:router(config)# commit
```

```
RP/0/RSP0/CPU0:router# show ipv4 interface brief | include Ten
TenGigE0/0/0/2/0  unassigned  Shutdown  Down
TenGigE0/0/0/2/1  unassigned  Shutdown  Down
TenGigE0/0/0/2/2  unassigned  Shutdown  Down
TenGigE0/0/0/2/3  unassigned  Shutdown  Down
TenGigE0/0/0/2/4  unassigned  Shutdown  Down
TenGigE0/0/0/2/5  unassigned  Shutdown  Down
TenGigE0/0/0/2/6  unassigned  Shutdown  Down
TenGigE0/0/0/2/7  unassigned  Shutdown  Down
TenGigE0/0/0/2/8  unassigned  Shutdown  Down
TenGigE0/0/0/2/9  unassigned  Shutdown  Down
```

**Upgrading the CPU Controller Bits**

Use this procedure to upgrade the CPU controller bits on all nodes that are installed in the router or on a specific node.

**SUMMARY STEPS**

1. admin
2. **upgrade cpuctrlbits** \{all | location node-id\}

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> admin</td>
<td>Enters administration EXEC mode.</td>
</tr>
<tr>
<td>Example:</td>
<td>RP/0/RSP0/CPU0:router# admin</td>
</tr>
<tr>
<td><strong>Step 2</strong> upgrade cpuctrlbits {all</td>
<td>location node-id}</td>
</tr>
<tr>
<td>Example:</td>
<td>RP/0/RSP0/CPU0:router(admin)# upgrade cpuctrlbits all</td>
</tr>
</tbody>
</table>
Examples

The following example shows how to upgrade the CPU controller bits on all nodes in a router:

```
RP/0/RSP0/CPU0:router# admin
RP/0/RSP0/CPU0:router(admin)# upgrade cpucrtlbits all
```

Please do not power cycle, reload the router or reset any nodes until all upgrades are completed.
Please check the syslog to make sure that all nodes are upgraded successfully. If you need to perform multiple upgrades, please wait for current upgrade to be completed before proceeding to another upgrade. Failure to do so may render the cards under upgrade to be unusable.

Additional References

The following sections provide references related to hardware management on Cisco IOS XR software.

**Related Documents**

<table>
<thead>
<tr>
<th>Related Topic</th>
<th>Document Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cisco IOS XR hardware commands</td>
<td>Hardware Redundancy and Node Administration Commands on the Cisco ASR 9000 Series Router module of System Management Command Reference for Cisco ASR 9000 Series Routers</td>
</tr>
<tr>
<td>Information about getting started with Cisco IOS XR software</td>
<td>Cisco ASR 9000 Series Aggregation Services Router Getting Started Guide</td>
</tr>
<tr>
<td>ROM Monitor</td>
<td>ROM Monitor Configuration Guide for Cisco ASR 9000 Routers</td>
</tr>
<tr>
<td>Cisco IOS XR command master list</td>
<td>Cisco ASR 9000 Series Aggregation Services Router Commands Master List</td>
</tr>
<tr>
<td>Information about user groups and task IDs</td>
<td>Configuring AAA Services on the Cisco ASR 9000 Series Router module of System Security Configuration Guide for Cisco ASR 9000 Series Routers</td>
</tr>
</tbody>
</table>
Standards

<table>
<thead>
<tr>
<th>Standards</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>No new or modified standards are supported by this feature, and support for existing standards has not been modified by this feature.</td>
<td>—</td>
</tr>
</tbody>
</table>

MIBs

<table>
<thead>
<tr>
<th>MIBs</th>
<th>MIBs Link</th>
</tr>
</thead>
<tbody>
<tr>
<td>—</td>
<td>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: <a href="http://cisco.com/public/sw-center/netmgmt/cmtk/mibs.shtml">http://cisco.com/public/sw-center/netmgmt/cmtk/mibs.shtml</a></td>
</tr>
</tbody>
</table>

RFCs

<table>
<thead>
<tr>
<th>RFCs</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>No new or modified RFCs are supported by this feature, and support for existing RFCs has not been modified by this feature.</td>
<td>—</td>
</tr>
</tbody>
</table>

Technical Assistance

<table>
<thead>
<tr>
<th>Description</th>
<th>Link</th>
</tr>
</thead>
<tbody>
<tr>
<td>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.</td>
<td><a href="http://www.cisco.com/cisco/web/support/index.html">http://www.cisco.com/cisco/web/support/index.html</a></td>
</tr>
</tbody>
</table>
Upgrading and Managing Cisco IOS XR Software

Cisco IOS XR software is divided into software packages so that you can select which features run on your router. This module describes the concepts and tasks necessary to add feature packages, upgrade the active set of packages, roll back to a previously active set of packages, and perform other related package management tasks.

For complete descriptions of the commands listed in this module, see Related Documents, on page 214. To locate documentation for other commands that might appear in the course of performing a configuration task, search online in Cisco ASR 9000 Series Aggregation Services Router Commands Master List.

**Table 23: Feature History for Upgrading and Managing Cisco IOS XR Software**

<table>
<thead>
<tr>
<th>Release</th>
<th>Modification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Release 3.7.2</td>
<td>The feature was introduced.</td>
</tr>
<tr>
<td>Release 3.9.0</td>
<td>No modification.</td>
</tr>
<tr>
<td>Release 4.0.0</td>
<td>A procedure to upgrade software from Cisco IOS XR Release 3.x was introduced. See Upgrading to Cisco IOS XR Software Release 4.0, on page 199. Support for installation commands was removed from EXEC mode. The ability to install software on a specific SDR was removed.</td>
</tr>
<tr>
<td>Release 6.0.1</td>
<td>Support was added for digitally signed images. See Digitally Signed Images, on page 166</td>
</tr>
</tbody>
</table>

This module contains the following topics:

- Overview of Cisco IOS XR Software Packages, on page 158
- Information About Package Management, on page 162
- Package Management Procedures, on page 174
- Rolling Back to a Previous Software Set, on page 211
- Additional References, on page 214
Overview of Cisco IOS XR Software Packages

Cisco IOS XR software is divided into software packages so that you can select which features run on your router. Each package contains the components to perform a specific set of router functions, such as routing, security, or modular services card (MSC) support. Bundles are groups of packages that can be downloaded as a set. For example, Cisco IOS XR Unicast Routing Core Bundle (known as mini) provides the main packages for use on every router.

Adding a package to the router does not affect the operation of the router—it only copies the package files to a local storage device on the router, known as the boot device (such as the compact flash drive). To make the package functional on the router, you must activate it for one or more cards.

To upgrade a package, you activate a newer version of the package. When the automatic compatibility checks have been passed, the new version is activated, and the old version is deactivated.

---

**Note**
Activating a software maintenance upgrade (SMU) does not cause any earlier SMUs or the package to which the SMU applies to be automatically deactivated.

---

**Note**
If an interface on a router does not have a configuration and is brought up by performing no-shut operation, then upon router reload, the interface state changes to admin-shutdown automatically.

---

To downgrade a package, you activate an older version of the package. When the automatic compatibility checks have been passed, the older version is activated, and the newer version is deactivated.

---

**Caution**
Do not perform any install operations when the router is reloading.

---

**Note**
For more information on the features and components included in each package, refer to the release notes.

---

Package Installation Envelopes

Package Installation Envelopes (PIEs) are nonbootable files that contain a single package or a set of packages (called a composite package or bundle). Because the files are nonbootable, they are used to add software package files to a running router.

PIE files have a pie extension. When a PIE file contains software for a specific bug fix, it is called a software maintenance upgrade (SMU).
Summary of Cisco IOS XR Software Packages

Every router includes a basic set of required packages contained in the Cisco IOS XR Unicast Routing Core Bundle. Additional optional packages can be added and activated on the router to provide specific features.

Packages in the Cisco IOS XR Unicast Routing Core Bundle

The packages contained in the Cisco IOS XR Unicast Routing Core Bundle are as follows:

- Operating system (OS) and minimum boot image (MBI)—Kernel, file system, memory management, and other slow changing core components.
- Base—Interface manager, system database, checkpoint services, configuration management, other slow-changing components.
- Routing—RIB, BGP, ISIS, OSPF, EIGRP, RIP, RPL, and other routing protocols.
- Forwarding—FIB, ARP, QoS, ACL, and other components.
- LC—Line card drivers.

The filename for this bundle is: `asr9k-mini.pie-version`.

Refer to the release notes for additional information on the specific features provided by each package.

Software Maintenance Upgrades

A software maintenance upgrade (SMU) is a PIE file that contains fixes for a specific defect. A composite SMU is a PIE file that contains SMUs for more than one package. SMUs are added and activated using the same procedures as other PIE files. SMUs are created to respond to immediate issues and do not include new features. Typically, SMUs do not have a large impact on router operations. SMU versions are synchronized to the package major, minor, and maintenance versions they upgrade.

The affect of an SMU depends on its type:

- Process Restart SMU—Causes a process or group of processes to restart on activation.
- Reload SMU—Causes a parallel reload (of RPs and line cards).

SMUs are not an alternative to maintenance releases. They provide quick resolution of immediate issues. All bugs fixed by SMUs are integrated into the maintenance releases. For information on available SMUs, contact Cisco Technical Support, as described in `Obtaining Technical Assistance` in the monthly `What’s New in Cisco Product Documentation`. 

Note

Files with the `vm` extension are bootable installation files used only to replace all current Cisco IOS XR software. These files are installed from ROM Monitor mode, which causes significant router downtime. Cisco Systems recommends installing or upgrading software packages only using PIE files as described in this document. For more information on `vm` files, see `ROM Monitor Configuration Guide for Cisco ASR 9000 Routers`. 
Activating a software maintenance upgrade (SMU) does not cause any earlier SMUs, or the package to which the SMU applies, to be automatically deactivated.

Note

Related Topics

Updating Software Images Without a Router Reload

PIE Filenames and Version Numbers

PIE filenames have two formats: one for composite-package PIEs (bundles) and one for single-package PIEs. A composite-package file is a PIE file that contains multiple packages.

Note

Hyphens in the filename are part of the filename.

Table 24: PIE Filenames, on page 160 shows the filenames for available PIE types.

Table 24: PIE Filenames

<table>
<thead>
<tr>
<th>Software Delivery Type</th>
<th>Filename</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Composite (Bundle) PIE</td>
<td>platform-compose_name.pie-major.minor.maintenance</td>
<td>asr9k-mini.pie-3.7.2</td>
</tr>
<tr>
<td>Single package PIE</td>
<td>platform-package_type.-p.pie-major.minor.maintenance</td>
<td>asr9k-mpls.pie-3.7.2</td>
</tr>
<tr>
<td>Composite SMU</td>
<td>comp-platform-compose_name.ddts.pie</td>
<td>comp-asr9k-001.CSCec98xxx.pie</td>
</tr>
<tr>
<td>Single package SMU</td>
<td>platform-package_type-major.minor.maintenance.ddts.pie</td>
<td>asr9k-base-3.7.2.C30ei45xxx.pie</td>
</tr>
</tbody>
</table>

Note

A SMU composite name usually is “001”, which means the SMU is the first SMU for that DDTS. In rare cases in which the same DDTS requires multiple composite SMUs, a second composite version number is released as “002”. In the previous example, a second composite SMU “comp-002.CSCec98766” would be created for DDTS CSCec98766.

Filename Component Description

The filename components for all packages are described in Table 25: Composite- and Single-Package Filename Components, on page 160.

Table 25: Composite- and Single-Package Filename Components

<table>
<thead>
<tr>
<th>Component</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>platform</td>
<td>Identifies the platform for which the software package is designed.</td>
</tr>
<tr>
<td></td>
<td>• The platform designation is “asr9k.”</td>
</tr>
<tr>
<td>Component</td>
<td>Description</td>
</tr>
<tr>
<td>-----------</td>
<td>-------------</td>
</tr>
</tbody>
</table>
| composite_name | Identifies a specific composite package.  
* The only composite PIE file at this time is named “mini” and includes all packages described in the Cisco IOS XR Unicast Routing Core Bundle. |
| package_type | Identifies the type of package the file supports (package_type applies only to single-package PIEs). Package types include:  
* mcast—Multicast package  
* mgbl—Manageability package  
* mpls—MPLS package  
* k9sec—Security package  
* diags—Diagnostics package  
* fpd—Field-programmable device package  
* doc—Documentation package |
| major | Identifies the major release of this package.  
* A major release occurs when there is a major architectural change to the product (for example, a major new capability is introduced).  
* All packages operating on the router must be at the same major release level.  
* A major release is the least frequent release and may require a router reboot. |
| minor | Identifies the minor release of this package.  
* A minor release contains one or more of the following:  
  * New features  
  * Bug fixes  
* The minor release version does not have to be identical for all software packages operating on the router, but the operating packages must be certified by Cisco as compatible with each other.  
* A minor release may require a router reboot. |
| maintenance | Identifies the maintenance release of this package.  
* A maintenance release contains a collection of bug fixes for a package.  
* The maintenance release version does not have to be identical for all software packages operating on the router, but the major and minor versions of the maintenance release must match those of the package being updated.  
* A maintenance release does not usually require a router reboot. |
| ddts | SMUs only. Identifies a DDTS\(^{10}\) number that describes the problem this SMU addresses. DDTS is the method used to track known bugs and the resolutions or workarounds for those issues. |
Copying the PIE File to a Local Storage Device or Network Server

To add an optional package or upgrade or downgrade a package, you must copy the appropriate PIE file to a local storage device or to a network file server to which the router has access.

If you need to store PIE files on the router, we recommend storing PIE files on the hard disk. Flash disk0: serves as the boot device for packages that have been added or activated on the system. Flash disk1: is used as a backup for disk0:

Tip

Before copying PIE files to a local storage device, use the `dir` command to check to see if the required PIE files are already on the device.

Information About Package Management

Summary of Package Management

The general procedure for adding optional packages, upgrading a package or package set, or downgrading packages on the router is as follows:

1. Copy the package file or files to a local storage device or file server.
2. Add the package or packages on the router using the command `install add`.
3. Activate the package or packages on the router using the `install activate` command.
4. Commit the current set of packages using the `install commit` command.

Figure 7: Process to Add, Activate, and Commit Cisco IOS XR Software Packages, on page 163 illustrates key steps in the package management process.
Adding Packages

Use the `install add` command to unpack the package software files from a PIE file and copy them to the boot device (usually disk0:).

- The package software files are added to the boot device of the DSC of the router from either administration EXEC or EXEC mode.

**Note**

The disk that holds the unpacked software files is also known as the boot device. By default, flash disk0: is used as the boot device. To use an alternate storage device, such as flash disk1:, see the `Router Recovery with ROM Monitor` module of `ROM Monitor Configuration Guide for Cisco ASR 9000 Routers`. Remember that all RSPs in a system must use the same boot device. If the boot device on the primary RSP is flash disk0:, then the standby RSP must also have a flash disk0:.

Verifying Package Details

Before you activate a package on the router, you can verify the type of upgrade that is required for the package and whether the package requires a router reload or not. Use the `show install package pie detail` command in admin mode.

```
RP/0/RSP0/CPFU0:router (admin)# show install package disk0:asr9k-px-4.x.x.04I.CSCuc66088-0.0.4.i detail
```

```
Mon Nov 19 09:44:24.036 UTC
disk0:asr9k-px-4.x.x.04I.CSCuc66088-0.0.4.i
asr9k-px-4.x.x.04I.CSCuc66088 V0.0.4.i[SMU] User specified bundle
iosxr-infra-asr9k-px1-4.x.x.04I.CSCuc66088.pi.pie.
[composite package]
[root package, grouped contents]
Vendor : Cisco Systems
Desc : User specified bundle iosxr-infra-asr9k-px1-4.x.x.04I.CSCuc66088.pi.pie.
Build : Built on Fri Nov 9 11:00:11 UTC 2012
Source : By iox-bld27 in /scratch1/SMU_BLD_WS/ci-431_206626_CSCuc66088_121109102249 for
pie  Card(s): RP, CRS-RP-X86, CRS8-RP-X86, CRS16-RP-X86, ASR9001-RP, RP-STARSCREAM,
NF24-4x10GE,
```
Activating Packages

Software packages remain inactive until activated with the `install activate` command.

After a package has been added to the router, use the `install activate` command to activate the package or SMUs for all valid cards. Information within the package is used to verify compatibility with the target cards and with the other active software. Actual activation is performed only after the package compatibility and application programming interface (API) compatibility checks have been passed.

**Note**

SDR-specific activation is supported for specific packages and upgrades, such as optional packages and SMUs. Packages that do not support SDR-specific EXEC mode activation can only be activated from administration EXEC mode.

Activating a Package on the Router

To activate a package on your router, use the `install activate` command in either administration EXEC mode or EXEC mode. If used in administration EXEC mode, the `install activate` command also activates the
package on all administration plane nodes and resources, including service processors (SPs), fabric SCs, fan controllers, alarm modules, and power modules.

**Note**

To enter administration EXEC mode, you must be logged in to the owner secure domain router (SDR) and have root-system access privileges.

You can also activate a package using the `install activate` command from EXEC mode.

### Activating Multiple Packages or SMUs

To install multiple packages or software maintenance upgrades (SMUs) with a single command, use the `install activate` command and either specify up to 16 packages by repeating `device: package` arguments or use wildcard syntax to specify multiple packages. Some SMUs may require a reload. If the operation requires a node reload, the user is prompted before the installation operation occurs.

**Related Topics**

- SMU Installation Combinations

### Activating All Packages Added in a Specific Operation

To install all packages that were added in a specific `install add` operation, use the `install activate` command with the `id add-id` keyword and argument, specifying the operation ID of the `install add` operation. You can specify up to 16 operations in a single command.

### Adding and Activating a Package with a Single Command

To add and activate a package with a single command, use the `install add` command with the `activate` keyword.

- To add and activate a package, enter the `install add` command with the `activate` keyword from administration EXEC mode.

- To add and activate a package in EXEC mode (where supported), enter the `install add` command with the `activate` keyword.

### Flexible XR Install

The Flexible XR Install feature allows you to upgrade as well as downgrade the software versions, packages and SMUs on the Cisco ASR 9000 Series Aggregation Services Router.

The Flexible XR Install feature automatically downloads all the packages that are required for installation. This is followed by compatibility testing, where the packages are checked for their compatibility with the running software or the software to be upgraded or downgraded. All required packages are extracted from specified repository to achieve SMUs dependencies.

This feature upgrades or downgrades the system using following sources:

- FTP
- TFTP
- Other local disks (for example, local harddisk, usb)
Digitally Signed Images

From Release 6.0.1 onwards, all Cisco IOS XR images are digitally signed to ensure the authenticity of the software. If the ROMMON/BIOS image on the line card is digitally signed, then ensure that the Cisco IOS XR image on the router is also digitally signed, as the ROMMON/BIOS checks the Cisco IOS XR image for a digital signature.

Note

The Cisco IOS XR Release 5.3.x images are not digitally signed. If you are running Cisco IOS XR Release 5.3.x, then ensure that you install the Abraxas based SMU for successful operation of the router with the latest line cards.

The digitally signed images are supported on the following line cards:

- A99-RP2-TR
- A99-RP2-SE
- A9K-RSP880-TR
- A9K-RSP880-SE
- A9K-8X100GE-SE
- A9K-8X100GE-TR
- A9K-4X100GE-SE
- A9K-4X100GE-TR
- A99-8X100GE-SE
- A99-8X100GE-TR
- A9K-MOD400-SE
- A9K-MOD400-TR
- A9K-MOD200-SE
- A9K-MOD200-TR
- A9K-400G-DWDM-TR
- A99-12X100GE

For more information on installing line cards, see Cisco ASR 9000 Series Aggregation Services Routers Ethernet Line Card Installation Guide.

Validation Messages

When image credentials, signature, and other attributes of the signature envelope are matched, the router reboots.

The following message is displayed on successful image validation.

File reception completed.**** check image validation ********...BIOS CODE SIGN ENTRY ...Image ASR9K-Tomahawk verified successfully~~~~~~~~~~~~~~~~~~~~~~~~~
If image validation is unsuccessful, the boot process is interrupted, and the router enters the ROMMON CLI mode.

The following message is displayed on unsuccessful image validation.

```
**** check image validation ****.......BIOS CODE SIGN ENTRY ... Image ASR9K-Tomahawk
Verification Failed Invalid signature offset ************************************ ASR9K
image validation failed, cannot boot image, contact tech support
************************************
```

**Upgrading and Downgrading Packages**

To upgrade a package, activate the latest version of the package; the previous version is automatically deactivated. To downgrade a package, activate the previous version of the package; the latest version is automatically deactivated.

Actual activation is performed only after compatibility checks have been passed.

---

**Note**

Activating a software maintenance upgrade (SMU) does not cause previous versions of the SMUs, or the package to which the SMU applies, to be automatically deactivated.

---

**Committing the Active Software Set**

When a package is activated on the router, it becomes part of the current running configuration. To make the package activation persistent across reloads, enter the `install commit` command. On startup, the designated shelf controller (DSC) of the secure domain router (SDR) loads the committed software set.

- To commit the active software set from administration EXEC mode, use the `install commit` command with the `sdr Owner` keywords. Alternatively, use the `install commit` command without keywords or arguments.

---

**Note**

If the system is restarted before the active software set is saved with the `install commit` command, the previously committed software set is used.

---

**Rolling Back to a Previous Installation Operation**

Although the term `commit` sounds final, the Cisco IOS XR software provides the flexibility to roll back the selected package set to previously saved package sets. Each time a package is activated or deactivated, a rollback point is created that defines the package set that is active after the package activation or deactivation. The software also creates a rollback point for the last committed package set. If you find that you prefer a previous package set over the currently active package set, you can use the `install rollback` command to make a previously active package set active again.

**Related Topics**

- Rolling Back to a Previous Software Set, on page 211
Multiple Disks Support during Installations

In installations on platforms where Cisco IOS XR Software is supported, only a single disk is used as an install device; that is, either disk0 or disk1. When multiple packages are installed on a single disk, it results in space constraints. To resolve this space limitation, the disk supported for the install operations has been extended to another disk called the disk1. When installing multiple packages, this feature enables you to choose between disk0 and disk1.

To add packages to a specific disk name, use the `install media` command in the admin configuration mode.

```
RP/0/RSP0/CPU0: router (admin) # install media disk1
```

Restrictions

- Before enabling the addition of disk1 through the `install media` command, the disk mirroring feature should be explicitly disabled. For details regarding disk mirroring, see the Disk Mirroring chapter.
- All single version packages should be installed into one disk; that is, either disk0 or disk1.
- When downgrading to an image that does not support extended disk, the rollback points of the extended disk will not be available on the downgraded image. For example, assume a case where the version1 (V1) image does not support the extended disk functionality and version2 (V2) image supports the functionality. Upgrading from V1(disk0) to V2(disk1), in such a case, makes the rollback points of V1 available on V2. However, when downgrading from V2(disk1) to V1(disk0), the rollback points of V2 will not be available on V1. For more information about the rollback feature and rollback points, see the Upgrading and Managing Software chapter.

Deactivation of fully superseded SMUs

Cisco IOS XR Software will accumulate a set of Software Maintenance Upgrades (SMUs) over time, where an older SMU gets superceded by the latest SMU. For example, if SMU A was initially delivered to you, and subsequently, as a result of a bug resolution, SMU B was delivered, then SMU A becomes the subset of SMU B and SMU A is superceded by SMU B. In this case, SMU A is redundant and can be deactivated to clean up the software package.

```
Note
When an older SMU gets superceded their code is no longer used but it can be used for rollback purposes which consumes the disk space.
```

When you install a reload SMU which supercedes the existing SMU the router reboots and SMU is placed in the superceded list automatically. If the superceded reload SMU is deactivated and fully supercedes the existing SMU, then router will not reboot when you run the `install deactivate superceded` command and the `install remove inactive` command.

```
Note
Removing the superceded SMUs will increase the disk space and it will not affect the functionality.
```

To deactivate all the fully superseded SMUs, use the `install deactivate superceded` command in the admin mode.

```
RP/0/RSP0/CPU0: router(admin) # install deactivate superceded
```
To display the details of the SMUs that are superseded, use the `show install superseded` command in the EXEC mode.

```
RP/0/RSP0/CP0: router # show install superseded
Thu Feb 3 17:37:20.379 UTC
disk0:asr9k-px-4.3.0.CSCud93518-1.0.0 is fully superseded by
disk0:asr9k-px-4.3.0.CSCue23747-1.0.0
```

**Support for the Ignore Package Presence Check Option**

During any software package upgrade in Cisco IOS XR Software, two versions of the packages get stored, both the previous version and the upgraded version. In Route Switch Processor 2 (RSP2), the disk space is insufficient to hold all packages of these two versions. To address this, a new optional keyword, `ignore-pkg-presence-check`, is added to the `install activate` command, which allows upgrading with lesser number of packages. For example, assume a case where version1 (V1) of the software consists of packages A, B, C, and D, and you want to upgrade to the version2 (V2) with only 3 packages (A, B, and C). The ignore-pkg-presence-check option allows only packages A, B, and C to be upgraded to V2 and deactivates package D of V1. Thus, an explicit deactivation of package D is not required and the user can add package D of V1 after upgrading to V2.

To upgrade software with lesser number of packages, use the `install activate [ignore-pkg-presence-check]` command in the admin mode.

```
RP/0/RSP0/CP0: router(admin) # install activate [ignore-pkg-presence-check] V2 packages
```

**Restrictions**

The restrictions for this option are:

- The ignore-pkg-presence-check keyword is supported only with the `install activate` command and is not supported with the `install add activate` command.

- When you upgrade using the ignore-pkg-presence-check option, the deactivation of packages always happens synchronously, using the synchronous keyword in the `install deactivate` command.

**Upgrading Packages**

To upgrade a package that is currently active on your router, add and activate a newer version of the same package (see Figure 8: Example of a Maintenance Release Package Upgrade, on page 170). The older version of the software package is deactivated automatically. These actions are permitted only after the package compatibility checks and API version compatibility checks have been passed.

Deactivated packages are not removed from the router. To remove inactive package files, use the `install remove` command.

**Caution**

Upgrading or downgrading a software package can cause a process to restart or a new process to start. Use the `test` option to preview the impact of the package activation.
Downgrading Packages

To downgrade a software package, activate an older version on one or more cards for which that package is already active. The newer version of the same software package is deactivated automatically. These actions are performed only after the package compatibility checks and API version compatibility checks have been passed.

Deactivated packages are not removed from the router. To remove inactive package files, use the `install remove` command. See the Related Topics section for links to more information.

Related Topics
Deactivating and Removing Cisco IOS XR Software Packages, on page 205

Impact of Package Version Changes

Each package version change has a different impact on the operation of the router, depending on the type of package and whether the upgrade is for a major, minor, or maintenance release. The following resources can provide more information on the impact of a package version change:

- See Related Topics for more information on the typical impact for major, minor, and maintenance releases.
- For specific information about the impact of an upgrade, consult the release notes for the package release, and test the impact of the package activation by adding the test option to the `install activate` command.
- The Cisco IOS XR Software Selector tool also contains information on package version compatibility.

Related Topics
PIE Filenames and Version Numbers, on page 160
Obtaining and Placing Cisco IOS XR Software, on page 175

Impact of Package Activation and Deactivation

Activation or deactivation of a package can have an immediate impact on the system. The system can be affected in the following ways:

- When a new package is activated, any new CLI commands for the package are added to the router. The router need not be restarted or reloaded.
• When a package is deactivated, the commands associated with the features being deactivated are removed from the router. The commands are no longer available to the user.
• During a software package deactivation, upgrade, or downgrade, any incompatible configurations are removed from the running configuration of the router, and saved to a file. Messages for incompatible configurations are displayed. Incompatible configurations are those configurations that are not supported by the new version of the software package.

**Note**
You must address any issues that result from the revised configuration and reapply the configuration, if necessary.

• New processes may be started.
• Running processes may be stopped or restarted.
• All processes in the cards may be restarted. Restarting processes in the cards is equivalent to a soft reset.
• The cards may reload.
• No impact: no processes in the card may be affected.

**Tip**
When activating and deactivating packages, use the **test** option to test the effects of a command without impacting the running system. After the activation or deactivation process completes, enter the **show install log** command to display the process results.

### Delaying the Return of the CLI Prompt

By default, the CLI prompt is returned to the screen before the installation operation is complete, which allows you to enter other commands that are not installation commands. If additional installation requests are attempted before the first operation is complete, they are not run.

To delay the return of the CLI prompt until an installation operation is complete, enter the **install** command with the **synchronous** keyword. For example:

```
install add disk1:/pie-file synchronous
install activate disk0:package synchronous
```

To determine if an **install** command is currently running, enter the **show install request** command.

### Displaying Installation Log Information

The install log provides information on the history of the installation operations. Each time an installation operation is run, a number is assigned to that operation.

• Use the **show install log** command to display information about both successful and failed installation operations.
• The **show install log** command with no arguments displays a summary of all installation operations. Specify the **request-id** argument to display information specific to an operation. Use the **detail** or **verbose** keywords to display details for specific operation.
• Use the **detail** or **verbose** keywords to display detailed information, including file changes, nodes that could be reloaded, impact to processes, and impact to Dynamic Link Libraries (DLLs).
By default, the install log stores up to 50 entries. Use the `clear install log-history` command to reset the number of entries to any value from 0 to 255.

### Examples

**Displaying install log Entries: Example**

The following example displays information for the install requests. Use the `verbose` keyword to display detailed information, including files changes, impact to processes, and impact to DLLs.

```
RP/0/RSP0/CPU0:router (admin)# show install log verbose
```

Install operation 1 started by user 'labuser' at 17:48:51 UTC Sat Jun 03 2009.
install add /disk1:asr9k-diags-p.pie-PD34-06.06.07
/disk1:asr9k-k9sec-p.pie-PD34-06.06.07 /disk1:asr9k-mcast-p.pie-PD34-06.06.07
/disk1:asr9k-mgbl-p.pie-PD34-06.06.07 /disk1:asr9k-mpls-p.pie-PD34-06.06.07
Install operation 1 completed successfully at 17:51:32 UTC Sat Jun 03 2009.

Install logs:
Install operation 1 'install add /disk1:asr9k-diags-p.pie-PD34-06.06.07
/disk1:asr9k-k9sec-p.pie-PD34-06.06.07 /disk1:asr9k-mcast-p.pie-PD34-06.06.07
/disk1:asr9k-mgbl-p.pie-PD34-06.06.07 /disk1:asr9k-mpls-p.pie-PD34-06.06.07'
started by user 'labuser' at 17:48:51 UTC Sat Jun 03 2009.
Info: The following packages are now available to be activated:
```
Info: disk0:asr9k-diags-3.7.2.1I
Info: disk0:asr9k-k9sec-3.7.2.1I
Info: disk0:asr9k-mcast-3.7.2.1I
Info: disk0:asr9k-mgbl-3.7.2.1I
Info: disk0:asr9k-mpls-3.7.2.1I
Info:
```

Install operation 1 completed successfully at 17:51:32 UTC Sat Jun 03 2009.
Install operation 2 started by user 'labuser' at 18:06:32 UTC Sat Jun 03 2009.
install activate disk0:asr9k-diags-3.7.2.1I disk0:asr9k-k9sec-3.7.2.1I
disk0:asr9k-mgbl-3.7.2.1I disk0:asr9k-mcast-3.7.2.1I disk0:asr9k-mpls-3.7.2.1I
Install operation 2 completed successfully at 18:07:48 UTC Sat Jun 03 2009.
Summary:
```
Install method: parallel
Summary of changes on nodes 0/1/SP, 0/6/SP, 0/SM0/SP, 0/SM1/SP, 0/SM2/SP, 0/SM3/SP:
Activated: asr9k-diags-3.7.2.1I
No processes affected
```

Summary of changes on nodes 0/1/CPU0, 0/6/CPU0:
```
Activated: asr9k-diags-3.7.2.1I
asr9k-mcast-3.7.2.1I
asr9k-mgbl-3.7.2.1I
1 asr9k-mpls processes affected (0 updated, 1 added, 0 removed, 0 impacted)
2 asr9k-mcast processes affected (0 updated, 2 added, 0 removed, 0 impacted)
```

Summary of changes on nodes 0/RP0/CPU0, 0/RP1/CPU0:
```
Activated: asr9k-diags-3.7.2.1I
asr9k-k9sec-3.7.2.1I
asr9k-mcast-3.7.2.1I
asr9k-mgbl-3.7.2.1I
asr9k-mpls-3.7.2.1I
6 asr9k-mgbl processes affected (0 updated, 6 added, 0 removed, 0 impacted)
```
8 asr9k-mpls processes affected (0 updated, 8 added, 0 removed, 0 impacted)
7 asr9k-k9sec processes affected (0 updated, 7 added, 0 removed, 0 impacted)
14 asr9k-mcast processes affected (0 updated, 14 added, 0 removed, 0 impacted)

Install logs:
Install operation 2 'install activate disk0:asr9k-diags-3.7.2.1I
disk0:asr9k-k9sec-3.7.2.1I disk0:asr9k-mcast-3.7.2.1I disk0:asr9k-mgbl-3.7.2.1I
disk0:asr9k-mpls-3.7.2.1I' started by user 'labuser' at 18:06:32 UTC Sat Jun 03 2009.
Info: The changes made to software configurations will not be
Info: persistent across system reloads. Use the command 'admin install
Info: commit' to make changes persistent.
Info: Please verify that the system is consistent following the
Info: software change using the following commands:
Info: show system verify
--More--

The following example displays information for a specific install request. Use the detail keyword
to display additional information, including impact to processes and nodes impacted.

RP/0/RSP0/CPU0:router(admin)# show install log 2 detail

Install operation 2 started by user 'labuser' at 18:06:32 UTC Sat Jun 03 2009.
install activate disk0:asr9k-diags-3.7.2.1I disk0:asr9k-k9sec-3.7.2.1I
disk0:asr9k-mcast-3.7.2.1I disk0:asr9k-mgbl-3.7.2.1I disk0:asr9k-mpls-3.7.2.1I
Install operation 2 completed successfully at 18:07:48 UTC Sat Jun 03 2006.

Summary:
Install method: parallel
Summary of changes on nodes 0/1/SP, 0/6/SP, 0/SM0/SP, 0/SM1/SP,
0/SM2/SP, 0/SM3/SP:
  Activated: asr9k-diags-3.7.2.1I
  No processes affected

Summary of changes on nodes 0/1/CPU0, 0/6/CPU0:
  Activated: asr9k-diags-3.7.2.1I
  asr9k-k9sec-3.7.2.1I
  asr9k-mcast-3.7.2.1I
  asr9k-mpls-3.7.2.1I
  1 asr9k-mpls processes affected (0 updated, 1 added, 0 removed, 0 impacted)
  2 asr9k-mcast processes affected (0 updated, 2 added, 0 removed, 0 impacted)

Summary of changes on nodes 0/RP0/CPU0, 0/RP1/CPU0:
  Activated: asr9k-diags-3.7.2.1I
  asr9k-k9sec-3.7.2.1I
  asr9k-mcast-3.7.2.1I
  asr9k-mgbl-3.7.2.1I
  asr9k-mpls-3.7.2.1I
  6 asr9k-mgbl processes affected (0 updated, 6 added, 0 removed, 0 impacted)
  8 asr9k-mpls processes affected (0 updated, 8 added, 0 removed, 0 impacted)
  7 asr9k-k9sec processes affected (0 updated, 7 added, 0 removed, 0 impacted)
  14 asr9k-mcast processes affected (0 updated, 14 added, 0 removed, 0 impacted)

Install logs:
Install operation 2 'install activate disk0:asr9k-diags-3.7.2.1I
disk0:asr9k-k9sec-3.7.2.1I disk0:asr9k-mcast-3.7.2.1I disk0:asr9k-mgbl-3.7.2.1I
disk0:asr9k-mpls-3.7.2.1I' started by user 'labuser' at 18:06:32 UTC
Sat Jun 03 2006.
Info: The changes made to software configurations will not be
Info: persistent across system reloads. Use the command 'admin install
Info: commit' to make changes persistent.
Info: Please verify that the system is consistent following the
Info: software change using the following commands:
Package Management Procedures

Note
Review the concepts about package management before performing the tasks described in this module.

Related Topics
Information About Package Management, on page 162

Activation and Deactivation Prerequisites
These prerequisites must be met for a package to be activated or deactivated:

• 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.

• Verify that all cards are installed and operating properly. For example, do not activate or deactivate packages while cards are booting, while cards are being upgraded or replaced, or when you anticipate an automatic switchover activity.

• If a ROM Monitor upgrade is required for the software package, the upgrade must be completed before the package is activated. For ROM Monitor upgrade information and procedures, see ROM Monitor Configuration Guide for Cisco ASR 9000 Routers.

• Check the sanity of the configuration file system and recover from any internal inconsistencies by using the cfs check command.

RP/0/RSP0/CPU0:router# cfs check

Tue Sep 20 07:22:03.374 DST

Creating any missing directories in Configuration File system...OK
Initializing Configuration Version Manager...OK
Syncing commit database with running configuration...OK

• Clear any inconsistency alarms and remove any failed configurations using the clear configuration inconsistency command.

An inconsistency alarm is set when there is a failure to restore the configuration; this can occur during router startup, or when a line card or route switch processor (RSP) card is inserted or removed. If an inconsistency alarm is set, a message similar to the one in this example is displayed:

RP/0/0/CPU0:May 26 11:58:40.662 : cfgmgr-rp[130]: %MGRL-CONFIGCLI-3
BATCH_CONFIG_FAIL : 28 config(s) failed during startup. To view failed config(s) use the command - "show configuration failed startup"

When the inconsistency alarm is set, all configuration commit operations fail until the alarm is cleared.
Although more than one version of a software package can be added to a storage device, only one version of a package can be active for any card.

Some packages require the activation or deactivation of other packages.

The package being activated must be compatible with the current active software set.

Package activation from EXEC mode is supported for specific packages and upgrades, such as optional packages and SMUs. Packages that do not support EXEC mode activation can only be activated for the entire router from administration EXEC mode.

Activation is performed only after the package compatibility checks and API version compatibility checks have been passed. If a conflict is found, an on-screen error message is displayed.

While a software package is being activated, other requests are not allowed to run on any of the impacted nodes. Package activation is completed when a message similar to this one appears:

Install operation 2 completed successfully at 20:30:29 UTC Mon Nov 14 2005.

Each CLI install request is assigned a request ID, which can be used later to review the events.

Obtaining and Placing Cisco IOS XR Software

This section contains information to locate the available software packages and to transfer them either to a local storage device or to a network server. When this is done, the package or packages can be added and activated on the router.

There are two primary ways to obtain packages in Cisco IOS XR software:

- Request the software from Cisco on a flash disk that you can insert into the removable flash disk slot (usually flash disk1:). Flash disk1: is optional. When it is installed, flash disk1: can be used to store PIE files, which can then be used to add new software to the boot device (usually flash disk0:).

- Download the Cisco IOS XR software packages to a local storage device of the DSC, such as flash disk1:, or to a remote server, such as a tftp or rcp server.

The boot device is the local disk on the DSC where Cisco IOS XR software is added and activated. PIE files should not be stored on this boot device. The default boot device is disk0:. All PIE files should be stored on flash disk1:.

Transferring Installation Files from a Network File Server to a Local Storage Device

If the Cisco IOS XR software PIE files are located on a remote TFTP, FTP, SFTP, or rcp server, you can copy the files to a local storage device such as disk1:. When the PIE files are located on a local storage device, the software packages can be added and activated on the router from that storage device. Table 26: Download Protocols Supported by Cisco IOS XR Software, on page 176 describes the supported server protocols, and the CLI syntax used copy files from each server type to the local storage device.

Tip

Cisco IOS XR software PIE files can also be added to the router boot device directly from the remote server.

Note

Consult your system administrator for the location and availability of your network server.
Table 26: Download Protocols Supported by Cisco IOS XR Software

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trivial File Transfer Protocol</td>
<td>TFTP allows files to be transferred from one computer to another over a network, usually without the use of client authentication (for example, username and password). It is a simplified version of FTP.</td>
</tr>
<tr>
<td></td>
<td><strong>Note</strong> Some Cisco IOS XR software images may be larger than 32 MB, and the TFTP services provided by some vendors may not support a file this large. If you do not have access to a TFTP server that supports files larger than 32 MB, download the software image using FTP or rcp.</td>
</tr>
<tr>
<td>File Transfer Protocol</td>
<td>FTP is part of the TCP/IP protocol stack and requires a username and password.</td>
</tr>
<tr>
<td>Remote Copy Protocol</td>
<td>The rcp protocol uses TCP to ensure the reliable delivery of data, and rcp downloads require a usernames.</td>
</tr>
<tr>
<td>SSH File Transfer Protocol</td>
<td>SFTP is part of the SSHv2 feature in the Security package and provides for secure file transfers. For more information, see the <em>System Security Configuration Guide for Cisco ASR 9000 Series Routers</em>.</td>
</tr>
</tbody>
</table>

The router commands listed in Table 27: Commands for Copying Package Files to the Router, on page 176 show how to copy package files to the router using three types of file transfer protocols.

Table 27: Commands for Copying Package Files to the Router

<table>
<thead>
<tr>
<th>Server Type</th>
<th>Command and Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>TFTP</td>
<td>The following command syntax is used:</td>
</tr>
<tr>
<td></td>
<td><code>copy tftp:// hostname_or_ipaddress / directory-path / pie-name disk1:</code></td>
</tr>
<tr>
<td></td>
<td>Example:</td>
</tr>
<tr>
<td></td>
<td><code>RP/0/RSP0/CPU0:router# copy tftp://10.1.1.1/images/comp-asr9k-mini.pie disk1:</code></td>
</tr>
<tr>
<td>FTP</td>
<td>The following command syntax is used:</td>
</tr>
<tr>
<td></td>
<td><code>copy ftp:// username : password@hostname_or_ipaddress / directory-path / pie-name disk1:</code></td>
</tr>
<tr>
<td></td>
<td>Example:</td>
</tr>
<tr>
<td></td>
<td><code>RP/0/RSP0/CPU0:router# copy ftp://john:secret@10.1.1.1/images/comp-asr9k-mini.pie disk1:</code></td>
</tr>
</tbody>
</table>
The following command syntax is used:

```
copy rcp://username @ hostname_or_ipaddress / directory-path / pie-name disk1:
```

Example:

```
RP/0/RSP0/CPU0:router# copy rcp://john@10.1.1.1/images/comp-asr9k-mini.pie disk1:
```

Table 28: Command Variables for Copying and Adding Packages from a Network Server, on page 177 describes the command variables for copying packages from a network server.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>hostname_or_ipaddress</td>
<td>Host name or IP address of the server that stores the source file.</td>
</tr>
<tr>
<td>pie-name</td>
<td>Name of the PIE file (package). See the Overview of Cisco IOS XR Software Packages, on page 158 for descriptions of the available packages.</td>
</tr>
<tr>
<td>username</td>
<td>Required for FTP and rcp only and must be a valid username on the FTP or rcp server.</td>
</tr>
<tr>
<td>password</td>
<td>Required for FTP only. If a password is not provided, the networking device accepts anonymous FTP.</td>
</tr>
<tr>
<td>directory-path</td>
<td>The specified directory should be a directory under the home directory of the user. In the rcp and FTP examples in Table 27: Commands for Copying Package Files to the Router, on page 176, the file being downloaded is in a subdirectory called “images” in the home directory of the user “john.”</td>
</tr>
</tbody>
</table>

**Note** For FTP and rcp services, `directory-path` is the directory relative to the `username` home directory. If you want to specify an absolute path for the directory, you must add a “/” following the server address.

When the installation files have been transferred to a network file server or the router, you are ready to activate or upgrade the software.

**Note** Files with the `vm` extension are bootable installation files used only to replace all current Cisco IOS XR software. These files are installed from ROM monitor mode and cause significant router downtime. We recommend installing or upgrading software packages using PIE files only, as described in this chapter. See ROM Monitor Configuration Guide for Cisco ASR 9000 Routers for information on installing from `vm` files.

**Related Topics**

- Adding and Activating Packages, on page 188
- Overview of Cisco IOS XR Software Packages, on page 158
Preparing for Software Installation Operations

This section includes instructions to prepare for software installation operations.

---

**Note**

Activation is performed only after the automatic package compatibility and API version compatibility checks have been passed. If a conflict is found, an on-screen error message is displayed.

---

**Before you begin**

Before adding or activating Cisco IOS XR software:

- Update the ROM Monitor software, if necessary.
- Determine if a software change is required.
- Verify that the new package is supported on your system. Some software packages require that other packages or package versions be activated, and some packages only support specific cards.
- Review the release notes for important information related to that release and to help determine the package compatibility with your router configuration.
- Verify that the system is stable and prepared for the software changes.

---

**SUMMARY STEPS**

1. `admin`
2. `show diag`
3. Update the ROMMON software if necessary.
4. `show install active`
5. `show install pie-info device:package [ brief | detail | verbose ]`
6. `verify packages`
7. `exit`
8. (Optional) `show system verify start`
9. (Optional) `show system verify [ detail | report ]`
10. `show clock`

---

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Step 1</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>admin</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Example:</td>
<td></td>
<td></td>
</tr>
<tr>
<td><code>RP/0/RSP0/CPU0:router# admin</code></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Step 2</strong></td>
<td><code>show diag</code></td>
<td>Displays the ROMMON software version for all cards in the system. Verify that the correct ROMMON software version is installed before upgrading a Cisco IOS XR software package.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
<td></td>
</tr>
<tr>
<td><code>RP/0/RSP0/CPU0:router(admin)# show diag</code></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Command or Action

<table>
<thead>
<tr>
<th>Step</th>
<th>Command</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>Update the ROMMON software if necessary.</td>
<td>Updates the ROMMON software. For instructions, see <a href="#">ROM Monitor Configuration Guide for Cisco ASR 9000 Routers</a>.</td>
</tr>
<tr>
<td>4</td>
<td><code>show install active</code></td>
<td>Displays the active software for the owner SDR. Use this command to determine what software should be added, upgraded or downgraded on the router, and to compare to the active software report after installation operations are complete.</td>
</tr>
<tr>
<td></td>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td><code>RP/0/RSP0/CPU0:router(admin)# show install active</code></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>`show install pie-info device:package [ brief</td>
<td>detail</td>
</tr>
<tr>
<td></td>
<td><code>device:package</code></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td><code>RP/0/RSP0/CPU0:router(admin)# show install pie-info</code></td>
<td></td>
</tr>
<tr>
<td></td>
<td><code>disk1:/asr9k-mcast-p.pie-3.8.30</code></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>verify packages</td>
<td>Verifies that there are no corrupted software files. The consistency of a previously installed software set is verified against the package file from which it originated. This command can be used as a debugging tool to verify the validity of the files that constitute the packages, to determine if there are any corrupted files. This command also checks for corruptions of installation state files and MBI image files. This command is particularly useful when issued after the activation of a package or upgrading the Cisco IOS XR software to a major release.</td>
</tr>
<tr>
<td></td>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td><code>RP/0/RSP0/CPU0:router(admin)# install verify packages</code></td>
<td></td>
</tr>
<tr>
<td>Command or Action</td>
<td>Purpose</td>
<td></td>
</tr>
<tr>
<td>-------------------</td>
<td>---------</td>
<td></td>
</tr>
<tr>
<td><strong>Note</strong></td>
<td>The <code>install verify packages</code> command can take up to two minutes per package to process.</td>
<td></td>
</tr>
<tr>
<td><strong>Step 7</strong> exit</td>
<td>Exits administration EXEC mode and returns to EXEC mode.</td>
<td></td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>RP/0/RSP0/CPU0:router(admin)# exit</td>
<td></td>
</tr>
<tr>
<td><strong>Step 8</strong> (Optional) <code>show system verify start</code></td>
<td>Starts the system status check.</td>
<td></td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>RP/0/RSP0/CPU0:router# show system verify start</td>
<td></td>
</tr>
<tr>
<td><strong>Step 9</strong> (Optional) `show system verify [ detail</td>
<td>report ]`</td>
<td>Displays system status information. A variety of information is displayed including the memory and CPU usage, process status, protocol status, and other status information. Use this information to verify that the system is stable. Enter this command in EXEC mode.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>RP/0/RSP0/CPU0:router# show system verify</td>
<td></td>
</tr>
<tr>
<td><strong>Step 10</strong> <code>show clock</code></td>
<td>Verifies that the system clock is correct. Software operations use certificates based on router clock times.</td>
<td></td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>RP/0/RSP0/CPU0:router# show clock</td>
<td></td>
</tr>
</tbody>
</table>

**Related Topics**

*Activation and Deactivation Prerequisites*, on page 174

**Examples**

**Verifying That the ROM Monitor Version Is Correct: Example**

In the following example, the ROM Monitor software version is displayed in the “ROMMON:” field for each card.
For instructions to upgrade the ROM Monitor software, see *ROM Monitor Configuration Guide for Cisco ASR 9000 Routers*.

RP/0/RSP0/CPU0:router# admin
RP/0/RSP0/CPU0:router(admin)# show diag

Mon Jun 22 12:55:10.554 PST

NODE module 0/RSP0/CPU0:

MAIN: board type 0x100302
S/N: FOC1230803H
Top Assy. Number: 68-3160-04
PID: A2K-RSP-4G-HDD-
UDI_VID: VP4
HwRev: V4.8
New Deviation Number: 0
CLEI: IPUCARJBA
Board State : IOS XR RUN
PLD: Motherboard: N/A, Processor: 0x8004 (rev: 2.2), Power: N/A
MONLIB: QNXFFS Monlib Version 3.2
ROMMON: Version 1.0(20081208:173612) [ASR9K ROMMON]
Board FPGA/CPLD/ASIC Hardware Revision:
- Compact Flash : V1.0
- XbarSwitch0 : V1.3
- XbarSwitch1 : V1.3
- XbarArbiter : V1.0
- XbarInterface : V0.0
- IntCtrl : V1.14
- ClkCtrl : V1.13
- PuntFPGA : V1.5
- HD : V3.0
- USB0 : V77.20
- USB1 : V77.20
- CPUCtrl : V1.17
- UTI : V1.6
- LIU : V1.0
- MLANSwitch : V0.0
- EOBCSwitch : V2.0
- CBC (active partition) : v1.2
- CBC (inactive partition) : v1.1

NODE fantray 0/FT0/SP:

MAIN: board type 0x900211
S/N:
Top Assy. Number: 32-0000-00
PID:
UDI_VID:
HwRev: V32.0
New Deviation Number: 0
CLEI:
PLD: Motherboard: N/A, Processor: N/A, Power: N/A
ROMMON:
Board FPGA/CPLD/ASIC Hardware Revision:
- CBC (active partition) : v4.0
- CBC (inactive partition) : v0.13
MAIN: board type 0x900211
S/N: 32-0000-00
PID: UDI_VID: HwRev: V32.0
New Deviation Number: 0
CLEI: PLD: Motherboard: N/A, Processor: N/A, Power: N/A
ROMMON:
Board FPGA/CPLD/ASIC Hardware Revision:
  CBC (active partition) : v4.0
  CBC (inactive partition) : v0.13

NODE module 0/1/CPU0 :

MAIN: board type 0x20207
S/N: FOC123081J6
Top Assy. Number: 68-3182-03
PID: A9K-40GE-B
UDI_VID: VID
HwRev: V0.0
New Deviation Number: 0
CLEI: Board State : IOS XR RUN
PLD: Motherboard: N/A, Processor: 0x8004 (rev: 2.2), Power: N/A
ROMMON: Version 1.0(20081208:174521) [ASR9K ROMMON]
Board FPGA/CPLD/ASIC Hardware Revision:
  NP0 : V3.194
  NP1 : V3.194
  NP2 : V3.194
  NP3 : V3.194
  XbarInterface : V18.4
    Bridge0 : V0.38
    Bridge1 : V0.38
  CPUUCtrl : V0.15
  USB : V77.20
  PortCtrl : V0.8
  PHYCtrl : V0.6
  40 Port Gigabit Ethernet Daughter board : V0.0
  CBC (active partition) : v2.2
  CBC (inactive partition) : v2.1

NODE module 0/4/CPU0 :

MAIN: board type 0x2020a
S/N: FOC123081JA
Top Assy. Number: 68-3183-02
PID: A9K-8T/4-B
UDI_VID: VID
HwRev: V0.0
New Deviation Number: 0
CLEI: IPU3AE0CAA
Board State : IOS XR RUN
PLD: Motherboard: N/A, Processor: 0x8004 (rev: 2.2), Power: N/A
ROMMON: Version 1.0(20081208:174521) [ASR9K ROMMON]
Board FPGA/CPLD/ASIC Hardware Revision:
  NP0 : V3.194
  NP1 : V3.194
  NP2 : V3.194
  NP3 : V3.194
  XbarInterface : V18.4
    Bridge0 : V0.38
Bridge1 : V0.38
CPUCtrl : V0.15
USB : V77.20
PortCtrl : V0.10
PHYCtrl : V0.7
PHY0 : V0.16
PHY1 : V0.16
PHY2 : V0.16
PHY3 : V0.16
PHY4 : V0.16
PHY5 : V0.16
PHY6 : V0.16
PHY7 : V0.16
8 Port Ten Gigabit Ethernet Daughter board : V0.0
CBC (active partition) : v2.2
CBC (inactive partition) : v2.1

NODE module 0/6/CPU0 :

MAIN: board type 0x20208
S/N: FHH12250033
Top Assy. Number: 68-3184-02
PID: A9K-4T-B
UDI_VID: V1D
HwRev: V0.0
New Deviation Number: 0
CLEI:
Board State : IOS XR RUN
PLD: Motherboard: N/A, Processor: 0x8004 (rev: 2.2), Power: N/A
ROMMON: Version 1.0(20081208:174521) [ASR9K ROMMON]
Board FPGA/CPLD/ASIC Hardware Revision:

NP0 : V3.194
NP1 : V3.194
NP2 : V3.194
NP3 : V3.194
XbarInterface : V18.4
Bridge0 : V0.38
Bridge1 : V0.38
CPUCtrl1 : V0.15
USB : V77.20
PHY0 : V0.16
PHY1 : V0.16
PHY2 : V0.16
PHY3 : V0.16
PortCtrl : V0.10
PHYCtrl : V0.7
4 Port Ten Gigabit Ethernet Daughter board : V0.0
CBC (active partition) : v2.2
CBC (inactive partition) : v2.1

NODE power-module 0/PM0/SP :

MAIN: board type 0xf00188
S/N:
Top Assy. Number: 341-00032-01
PID: A9K-3KW-AC
UDI_VID: V00
HwRev: V0.0
New Deviation Number: 0
CLEI: ACACACACAC
PLD: Motherboard: N/A, Processor: N/A, Power: N/A
ROMMON:
Board FPGA/CPLD/ASIC Hardware Revision:
NODE power-module 0/PM1/SP :

MAIN: board type 0xf00188
S/N:
Top Assy. Number: 341-00032-01
PID: A9K-3KW-AC
UDI_VID: V00
HwRev: V0.0
New Deviation Number: 0
CLEI: ACACACACAC
PLD: Motherboard: N/A, Processor: N/A, Power: N/A
ROMMON:
Board FPGA/CPLD/ASIC Hardware Revision:

NODE power-module 0/PM2/SP :

MAIN: board type 0xf00188
S/N:
Top Assy. Number: 341-00032-01
PID: A9K-3KW-AC
UDI_VID: V00
HwRev: V0.0
New Deviation Number: 0
CLEI: ACACACACAC
PLD: Motherboard: N/A, Processor: N/A, Power: N/A
ROMMON:
Board FPGA/CPLD/ASIC Hardware Revision:

Rack 0 - ASR-9010 Chassis, Includes Accessories
RACK NUM: 0
S/N:
PID: ASR-9010 Backplane
VID: 0.1
Desc: ASR-9010 Chassis, Includes Accessories
CLEI: NOCLEI
Top Assy. Number: 68-1234-56

Displaying the Active Software for the Entire System: Example

The following example displays the active packages for the entire system. Use this information to determine if a software change is required:

RP/0/RSP0/CPU0:router (admin) # show install active summary

Mon Jun 22 13:01:46.438 PST
Default Profile:
SDRs:
Owner
Active Packages:
disk0:comp-asr9k-mini-3.9.0.12I
disk0:asr9k-fpd-3.9.0.12I
disk0:asr9k-k9sec-3.9.0.12I
disk0:asr9k-mcast-3.9.0.12I
disk0:asr9k-mgbl-3.9.0.12I
disk0:asr9k-mpls-3.9.0.12I
Displaying Information About the Contents of a PIE File: Example

In the following example, information is displayed about the manageability PIE. This command displays the expiry date of the package, the cards supported by the package, and other details. Use this information to verify the compatibility of the package with your system and other software packages.

A software activation is performed only after the automatic package compatibility and API version compatibility checks have been passed. If a conflict is found, an on-screen error message is displayed.

Note

```
RP/0/RSP0/CPU0:router(admin)# show install pie-info disk1:/
asr9k-mgbl-p.pie-3.8.0 detail

Contents of pie file '/disk1:/asr9k-mgbl-p.pie-3.8.0':
  Expiry date : Jan 19, 2007 02:55:56 UTC
  Uncompressed size : 17892613

  asr9k-mgbl-3.8.0
  asr9k-mgbl V3.8.0[00] Manageability Package
  Vendor : Cisco Systems
  Desc : Manageability Package
  Build : Built on Wed May 10 08:04:58 UTC 2006
  Source : By edde-bld1 in /vws/aga/production/3.8.0/asr9k/workspace for c28
  Card(s): RP, DRP, DRPSC

  Restart information:
    Default: parallel impacted processes restart
    Components in package asr9k-mgbl-3.8.0, package asr9k-mgbl:
      manageability-cwi V[r33x/2] Craft Web Interface related binaries ae
      asr9k-feature-ipsla V[r33x/1] IPSLA time stamping feature
      doc-asr9k-mgbl V[r33x/2] Contains the man page documentation for asr9ks
```

Verifying That There Are No Corrupted Software Files: Example

The following sample output verifies the consistency of the currently active software against the file from which it originated:

```
RP/0/RSP0/CPU0:router(admin)# install verify packages

Mon Jun 22 13:19:08.590 PST
Install operation 3 '(admin) install verify packages' started by user 'user'
The install operation will continue asynchronously.
RP/0/RSP0/CPU0:router(admin)#Info:
This operation can take up to 2 minutes per package being verified.
Info: Please be patient.

Info: 0/6/cpu0 [LC] [SDR: Owner]
Info: meta-data: [SUCCESS] Verification Successful.
```
Info: 0/1/CPU0 [LC] [SDR: Owner]
Info: meta-data: [SUCCESS] Verification Successful.
Info: 0/RSP0/CPU0 [RP] [SDR: Owner]
Info: meta-data: [SUCCESS] Verification Successful.
Info: 0/4/CPU0 [LC] [SDR: Owner]
Info: meta-data: [SUCCESS] Verification Successful.
Info: Successful.
Info: /install/asr9k-scfclient-3.9.0.12I: [SUCCESS] Verification
Info: Successful.
Info: Verification Summary:
Info: 0/6/CPU0: ERROR. Anomalies found.
Info: 0/1/CPU0: ERROR. Anomalies found.
Info: 0/4/CPU0: ERROR. Anomalies found.
Info: 0/RSP0/CPU0: ERROR. Anomalies found.
Info: Anomalies found on the primary RP.
Info: No standby RP is present.
Info: Please contact your technical services representative to repair
Info: the system.

Verifying the Current System Status: Example

The following example shows how to prepare for system verification:

RP/0/RSP0/CPU0:router# show system verify start

Storing initial router status ...
done.

The following example shows output from running the show system verify command.

Note

Although most of the output should display the status “OK,” some processes may show other output, such as “Warning.” This does not specifically indicate a problem. Contact your Cisco technical support representative for more information on the output of this command.

RP/0/RSP0/CPU0:router# show system verify

Getting current router status ...
System Verification Report
---------------------------
- Verifying Memory Usage
  - Verified Memory Usage : [OK]
- Verifying CPU Usage
  - Verified CPU Usage : [OK]
- Verifying Blocked Processes
  - Verified Blocked Processes : [OK]
- Verifying Aborted Processes
  - Verified Aborted Processes : [OK]
- Verifying Crashed Processes
  - Verified Crashed Processes : [OK]
- Verifying LC Status
  - Verified LC Status : [OK]
- Verifying QNET Status
  Unable to get current LC status info
  - Verified QNET Status : [FAIL]
- Verifying GSP Fabric Status
  - Verified GSP Fabric Status : [OK]
- Verifying GSP Ethernet Status
gsp WARNING messages for router
Current set of gsp ping nodes does not match initial set of nodes
- Verified GSP Ethernet Status : [WARNING]
- Verifying POS interface Status
- Verified POS interface Status : [OK]
- Verifying TenGigE interface Status
- Verified TenGigE interface Status : [OK]
- Verifying TCP statistics
- Verified TCP statistics : [OK]
- Verifying UDP statistics
tcp_udp_raw WARNING messages for router
UDP Packets sent has not increased during this period.
- Verified UDP statistics : [WARNING]
- Verifying RAW statistics
- Verified RAW statistics : [OK]
- Verifying RIB Status
- Verified RIB Status : [OK]
- Verifying CEF Status
- Verified CEF Status : [OK]
- Verifying CEF Consistency Status
- Verified CEF Consistency Status : [OK]
- Verifying BGP Status
- Verified BGP Status : [OK]
- Verifying ISIS Status
- Verified ISIS Status : [OK]
- Verifying OSPF Status
- Verified OSPF Status : [OK]
- Verifying Syslog Messages
- Verified Syslog Messages : [OK]

System may not be stable. Please look into WARNING messages.

Verifying That the System Clock Is Correct: Example

The following example displays the current system clock setting:

RP/0/RSP0/CPU0:router# show clock
02:14:51.474 PST Wed Jan 28 2009

Adding and Activating Packages

The procedure in this section describes how to upgrade or add Cisco IOS XR software PIE files that are stored on a local storage device, such as a flash disk, or on a remote TFTP, FTP, SFTP, or rcp server. The PIE software file can include any of the following:

- The Cisco IOS XR Unicast Routing Core Bundle (six packages in one composite PIE file)
- Any of the optional packages (one package per PIE file)
- Software maintenance upgrades (SMUs)

When you need to add and activate two or more of the preceding package types, you should add and activate them in the order listed above.
When adding and activating two or more packages, optional packages can be activated together. Also, if the operation is a reload, multiple packages can be activated together. For example, five reload SMUs can be activated together or the Cisco IOS XR Unicast Routing Core Bundle plus the SMUs and optional packages can be activated together.

For a description of the software management process, see the Related Topics section.

These instructions are also used to downgrade software packages.

By default, installation operations are performed asynchronously: the CLI prompt is returned before the operation is complete, allowing the operator to continue work while the installation is completed in the background. Use the {synchronous} keyword at the end of install commands to delay the return of the CLI prompt until an installation operation is complete. See the Related Topics section for more information.

**Before you begin**

Before upgrading or adding packages, verify that these prerequisites have been met:

- Verify that the ROMMON version is correct. For instructions on upgrading ROM Monitor, see ROM Monitor Configuration Guide for Cisco ASR 9000 Routers.
- All packages to be upgraded or added are present on a local storage device (for example a flash disk), or a network file server.
- Prerequisites for the activation of packages are met as described in the Prerequisites section.
- Complete the procedures described in the Preparing for Software Installation Operations, on page 178 section.

To use the automatic FPD upgrade feature, the {fpd auto-upgrade} command must be enabled in administration configuration mode.

**SUMMARY STEPS**

1. Connect to the console port and log in.
2. (Optional) dir flash-disk:
3. admin
4. install add [source source-path | tar] file [activate]
5. (Optional) show install inactive summary
6. install activate {id add-id | device package} [test] [location node-id] [pause sw-change] [sdr sdr-name] [prompt-level {all | none}] [auto-abort-timer {time | off}]
7. Repeat Step 4, on page 190 through Step 6, on page 191 until all packages are activated.
8. (Optional) show install active summary
9. (Optional) install verify packages
10. (Optional) exit
11. (Optional) show system verify start
12. admin
13. (Optional) `install commit`

14. Upgrade the field-programmable device (FPD) software, if necessary.

### DETAILED STEPS

<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1</td>
<td>Connect to the console port and log in.</td>
<td>Establishes a CLI management session with the SDR. Connect to the console port for the active DSC. For more information on console connections, see Cisco ASR 9000 Series Aggregation Services Router Getting Started Guide.</td>
</tr>
<tr>
<td>Step 2</td>
<td>(Optional) <code>dir flash-disk :</code></td>
<td>Displays the package files that are available for package upgrades and additions. <strong>Note:</strong> Only PIE files can be added and activated using this procedure.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RP/0/RSP0/CPU0:router# dir disk1:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Step 3</td>
<td>Required: <code>admin</code></td>
<td>Enters administration EXEC mode. <strong>Note:</strong> Some <code>show install</code> commands can be entered in EXEC mode on an SDR.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RP/0/RSP0/CPU0:router# admin</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Step 4</td>
<td>`install add [source source-path</td>
<td>tar] file [activate ]`</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RP/0/RSP0/CPU0:router(admin)# install add disk1:/asr9k-mqbl-px.pie-6.0.1</td>
<td></td>
<td>• If the <code>source</code> keyword is used, the <code>source-path</code> specifies the directory path that is used for multiple filenames in the same directory.</td>
</tr>
<tr>
<td>or</td>
<td></td>
<td>• If the <code>tar</code> keyword is used, all PIE files contained in the tar file are unpacked.</td>
</tr>
<tr>
<td>RP/0/RSP0/CPU0:router(admin)# install add source tftp://10.1.1.1/images/ asr9k-k9sec-p.pie asr9k-mpls-p.pie asr9k-mcast-p.pie</td>
<td></td>
<td>The <code>file</code> argument can take any of these formats:</td>
</tr>
<tr>
<td>or</td>
<td></td>
<td>• <code>device filename</code></td>
</tr>
<tr>
<td>RP/0/RSP0/CPU0:router(admin)# install add source rcp://john:secret@10.1.1.1/images/asr9k-iosxr-3.6.0.tar</td>
<td></td>
<td>• <code>tftp://hostname_or_ipaddress /directory-path/filename</code></td>
</tr>
<tr>
<td>or</td>
<td></td>
<td>• <code>ftp://username:password@hostname_or_ipaddress /directory-path/filename</code></td>
</tr>
<tr>
<td>RP/0/RSP0/CPU0:router(admin)# install add tar rcp://john@10.1.1.1/images/asr9k-iosxr-3.6.0.tar</td>
<td></td>
<td>• <code>rcp://username@hostname_or_ipaddress /directory-path/filename</code></td>
</tr>
</tbody>
</table>

These are descriptions for each of the terms used here:
- **device**—Name of the local storage device where the PIE file is stored, such as `disk1:/`
- **filename**—Name of the PIE file you want to add. If the `tar` keyword is used, the `file` argument is the name
<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>• tftp://</td>
<td>Unpacks the PIE file from a network server using Trivial File Transfer Protocol.</td>
</tr>
<tr>
<td>• ftp://</td>
<td>Unpacks the PIE file from a network server using File Transfer Protocol.</td>
</tr>
<tr>
<td>• rcp://</td>
<td>Unpacks the PIE file from a network server using Remote Copy Protocol</td>
</tr>
<tr>
<td>• hostname_or_ipaddress</td>
<td>Host name or IP address of the network file server.</td>
</tr>
<tr>
<td>• directory-path</td>
<td>Network file server path that leads to the PIE file to be added.</td>
</tr>
<tr>
<td>• username</td>
<td>Username of user that has access privileges to the directory in which the PIE file is stored.</td>
</tr>
<tr>
<td>• password</td>
<td>Password associated with the username of user that has access privileges to the directory in which the PIE file is stored.</td>
</tr>
<tr>
<td>• activate</td>
<td>Automatically activates the software package after it is successfully added.</td>
</tr>
</tbody>
</table>

**Note**  
Multiple versions of a software package can be added to the storage device without impacting the running configuration, but only one version of a package can be activated for a card.

**Tip**  
The automatic FPD upgrade occurs only when the FPD pie is added and activated together with the install PIE.

### Step 5
(Optional) **show install inactive summary**

**Example:**

```
RP/0/RSP0/CPU0:router(admin)# show install inactive summary
```

Displays the inactive packages on the router. Verify that the package added in the previous step appears in the display.

### Step 6
```
install activate {id add-id | device package} [test] [location node-id] [pause sw-change] [sdr sdr-name] [prompt-level {all | none}] [auto-abort-timer {time | off}]
```

**Example:**

```
RP/0/RSP0/CPU0:router(admin)# install activate disk0:asr9k-mini-px-4.3.99
```

Activates a package that was added to the router. (Skip this step if the package was activated earlier with the **install add** command.)

- **id add-id**—Specifies the package using the operation ID of the **install add** operation in which you added the package. The operation ID is provided in the output of the **install add** command. You can also use **show install log** to display installation operation IDs.
- **device:package**—Specifies the package by name. Replace the **device:package** argument with the name...
<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Press ? after a partial package name to display all possible matches available for activation. If there is only one match, press [TAB] to fill in the rest of the package name.</td>
<td></td>
</tr>
<tr>
<td><strong>Note</strong></td>
<td>By default, packages are activated for all cards supported by that package.</td>
</tr>
<tr>
<td><strong>location node-id</strong>—Activates a package for a specific card (node). To display a list of node IDs for the entire system, enter the <code>show platform</code> command in administration EXEC mode. A package cannot be activated on a single node unless some version of the package being activated is already active on all nodes.</td>
<td></td>
</tr>
<tr>
<td><strong>Note</strong></td>
<td>The package being activated must be compatible with the currently active software to operate. When an activation is attempted, the system runs an automatic compatibility check to ensure that the package is compatible with the other active software on the router. The activation is permitted only after all compatibility checks have been passed.</td>
</tr>
<tr>
<td><strong>pause sw-change</strong>—Pauses the operation after preparatory checks and before the configuration is locked for the actual activation. This action enables you to hold the operation while you perform configuration changes, and proceed with the activation whenever you choose. This operation is useful, for example, if your workflow involves configuring a router out of the network during software installation and you want to minimize the time that the router is out of the network. Follow onscreen instructions to control the pausing and completion of the operation.</td>
<td></td>
</tr>
<tr>
<td><strong>prompt-level</strong>—Use a prompt-level of <strong>all</strong> to view all stages of the installation process and to specify whether to continue, or not.</td>
<td></td>
</tr>
<tr>
<td><strong>auto-abort-timer</strong>—Specifies an abort timer value, in minutes, which when expired loads the last committed loadpath. The default is 60. The timer is enabled by default. After the installation, if the activated software is working correctly, use the <code>install commit</code> command to cancel the timer and commit the new loadpath.</td>
<td></td>
</tr>
<tr>
<td>Command or Action</td>
<td>Purpose</td>
</tr>
<tr>
<td>-------------------</td>
<td>---------</td>
</tr>
<tr>
<td><strong>When activating packages,</strong> use the <strong>test</strong> option to test the effects of a command without impacting the running system. After the activation process finishes, enter the <strong>show install log</strong> command to display the process results. <strong>Tip</strong></td>
<td></td>
</tr>
<tr>
<td><strong>The automatic FPD upgrade occurs only when the FPD pie is added and activated together with the install PIE.</strong> <strong>Tip</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Step 7</strong></td>
<td>Repeat Step 4, on page 190 through Step 6, on page 191 until all packages are activated. Activates additional packages as required.</td>
</tr>
<tr>
<td><strong>Step 8</strong></td>
<td>(Optional) <strong>show install active summary</strong> Displays all active packages. Use this display to determine if the correct packages are active:</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td><code>RP/0/RSP0/CPU0:router(admin)# show install active</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 9</strong></td>
<td>(Optional) <strong>install verify packages</strong> Verifies the consistency of a installed software set with the package file from which it originated. This command can be used as a debugging tool to verify the validity of the files that constitute the packages, to determine whether there are any corrupted files. This command also checks for corruptions of installation state files and MBI image files. This command is particularly useful when issued after the activation of a package or upgrading the Cisco IOS XR software to a major release. <strong>Note</strong> The <strong>install verify packages</strong> command can take up to two minutes for each package to process.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td><code>RP/0/RSP0/CPU0:router(admin)# install verify packages</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 10</strong></td>
<td>(Optional) <strong>exit</strong> Exits administration EXEC mode and returns to EXEC mode.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td><code>RP/0/RSP0/CPU0:router(admin)# exit</code></td>
<td>Use this command only if you performed the installation operations in administration EXEC mode.</td>
</tr>
<tr>
<td><strong>Step 11</strong></td>
<td>(Optional) <strong>show system verify start</strong> Starts the system status check.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td><code>RP/0/RSP0/CPU0:router# show system verify start</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 12</strong></td>
<td><strong>admin</strong> Enters administration EXEC mode.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td><code>RP/0/RSP0/CPU0:router# admin</code></td>
<td></td>
</tr>
</tbody>
</table>
### Examples

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
</table>
| **Step 13** (Optional) **install commit** | Commits the current set of packages for an SDR or for all SDRs so that these packages are used if the router is restarted.  
- This command can be used from either administration EXEC or EXEC mode. |

**Example:**

```
RP/0/RSP0/CPU0:router# dir disk1:
```

```
RP/0/RSP0/CPU0:router(admin)# install commit
```

For more information, see the Related Topics section.

<table>
<thead>
<tr>
<th>Step 14</th>
<th>Upgrade the field-programmable device (FPD) software, if necessary.</th>
</tr>
</thead>
</table>
| **Purpose** | Whenever a Cisco IOS XR software image that supports SPAs and SIPs is released, a companion SPA or SIP FPD image is bundled with the Cisco IOS XR software release. Generally, the FPD image is not automatically upgraded. You must manually upgrade the FPD image running on the SPA or SIP when you upgrade the Cisco IOS XR software image. FPD versions must be compatible with the Cisco IOS XR software that is running on the router.  
**Note** If you have enabled the **fpd auto-upgrade** command and add and activate the FPD PIE together with the software installation PIE, the FPD image is automatically upgraded before the router is rebooted.  
For information on FPDs, including instructions to upgrade FPD images, see the Upgrading FPD Cisco IOS XR Software section. |

### Related Topics

- Obtaining and Placing Cisco IOS XR Software, on page 175  
- Activation and Deactivation Prerequisites, on page 174  
- Preparing for Software Installation Operations, on page 178  
- Information About Package Management, on page 162  
- Downgrading Packages, on page 170  
- PIE Filenames and Version Numbers, on page 160  
- Committing the Active Package Set, on page 197  
- Prerequisites for ISSU  
- Restrictions for ISSU  
- ISSU Software Images

### Examples

#### Adding a Package: Example

The following example shows how to add the contents of a PIE file on disk1: to the boot device. Because the software package is added to the boot device by default, it is not necessary to specify the destination device in the CLI.
From Cisco IOS XR Software Release 6.0.1 and later, you must append a forward slash ('/') to the source location (for example, disk1:/) of the PIE file in the `install add` command.

RP/0/RSP0/CPU0:router(admin)# install add disk1:/asr9k-mpls-px.pie-6.0.1 synchronous

Install operation 4 'install add /disk1:/asr9k-mpls-px.pie-6.0.1 synchronous' started by user 'cisco' at 18:10:18 UTC Sat Apr 08 2009.
Info: The following package is now available to be activated:
Info: disk0:asr9k-mpls-px-6.0.1
Info:
Install operation 4 completed successfully at 18:14:11 UTC Sat Apr 08 2009.

The following example shows how to add the contents of a PIE file on a TFTP server to the boot device:

RP/0/RSP0/CPU0:router(admin)# install add tftp://209.165.201.1/asr9k-mpls.pie synchronous

Install operation 4 '(admin) install add /tftp://209.165.201.1/asr9k-mpls.pie synchronous' started by user 'cisco' at 18:16:18 UTC Thu Jan 03 2009.
Info: The following package is now available to be activated:
Info: disk0:asr9k-mpls-3.7.2
Info:
Install operation 4 completed successfully at 18:19:10 UTC Thu Jan 03 2009.

**Activating a Package: Example**

The following example shows the activation of the MPLS package. The package is activated on the boot device disk0:

RP/0/RSP0/CPU0:router(admin)# install activate disk0: asr9k-mpls-3.7.2 synchronous

Install operation 15 'install activate disk0:asr9k-mpls-3.7.2 synchronous' started by user 'lab' at 19:15:33 UTC Sat Apr 08 2009.
Info: The changes made to software configurations will not be persistent across system reloads. Use the command 'admin install commit' to make changes persistent.
Info: Please verify that the system is consistent following the software change using the following commands:
Info: show system verify
Info: install verify packages
Install operation 5 completed successfully at 19:16:18 UTC Sat Apr 08 2009.
Activating a Package by Specifying an Operation ID: Example

The following example shows the activation of the MPLS package using the operation ID of the install add operation that added the package:

```
RP/0/RSP0/CPU0:router(admin)# install activate id 4
```

Install operation 5 'install activate id 4' started by user 'lab' via CLI at 18:20:17 UTC Thu Jan 03 2009.

```
Info: This operation will activate the following package:
Info: disk0:asr9k-mpls-3.7.2
Info: Install Method: Parallel Process Restart
```

The install operation will continue asynchronously.

```
Info: The changes made to software configurations will not be persistent across system reloads. Use the command 'install commit' to make changes persistent.
Info: Please verify that the system is consistent following the software change using the following commands:
Info: show system verify
Info: install verify packages
Install operation 5 completed successfully at 18:21:30 UTC Thu Jan 03 2009.
```

Adding and Activating a Package from an FTP File Server with One Command: Example

To add and activate a package with a single command, enter the install add command with the activate keyword. In the following example, the Manageability PIE located on disk1: is verified, unpacked, and added to the boot device disk0. Because this operation is performed in administration EXEC mode, the package is activated for all SDRs in the system.

```
RP/0/RSP0/CPU0:router(admin)# install add disk1:/asr9k-mgbl-px.pie-6.0.1 activate
```

Install operation 4 'install add /disk1:/asr9k-mgbl-px.pie-6.0.1 activate' started by user 'cisco' at 07:58:56 UTC Wed Mar 01 2009.

The install operation will continue asynchronously.

```
:router(admin)#Part 1 of 2 (add software): Started
Info: The following package is now available to be activated:
Info: disk0:asr9k-mgbl-px.pie-6.0.1
Part 1 of 2 (add software): Completed successfully
Part 2 of 2 (activate software): Started
Info: The changes made to software configurations will not be persistent across system reloads. Use the command 'admin install commit' to make changes persistent.
Info: Please verify that the system is consistent following the software change using the following commands:
Info: show system verify
Info: install verify packages
Part 2 of 2 (activate software): Completed successfully
Part 1 of 2 (add software): Completed successfully
Part 2 of 2 (activate software): Completed successfully
Install operation 4 completed successfully at 08:00:24 UTC Wed Mar 01 2009.
```
Displaying the Active Packages: Example

The following example displays a summary of the active packages on a router. Because this operation is performed in administration EXEC mode, the active packages for all SDRs are displayed.

```
RP/0/RSP0/CPU0:router(admin)# show install active summary
Mon Jun 22 23:41:19.509 PST
Default Profile:
SDRs:
Owner
Active Packages:
disk0:comp-asr9k-mini-3.9.0.12I
disk0:asr9k-fpd-3.9.0.12I
disk0:asr9k-k9sec-3.9.0.12I
disk0:asr9k-mcast-3.9.0.12I
disk0:asr9k-mgbl-3.9.0.12I
disk0:asr9k-mpls-3.9.0.12I
```

Committing the Active Package Set

When a package is activated, it becomes part of the current running configuration. To make the package activation persistent across system-wide reloads, enter the `install commit` command. On startup, DSC of the owner SDR loads this committed software set. If the system is reloaded before the current active software is committed with the `install commit` command, the previously committed software set is used.

If the system is reloaded before the current active software is committed with the `install commit` command, the previously committed software set is used.

Tip

Before committing a package set, verify that the SDR is operating correctly and is forwarding packets as expected.

SUMMARY STEPS

1. admin
2. install commit
3. show install committed [detail | summary | verbose] [location node-id]

DETAILED STEPS

<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1</td>
<td>admin</td>
<td>Enters administration EXEC mode.</td>
</tr>
<tr>
<td>Example:</td>
<td>RP/0/RSP0/CPU0:router# admin</td>
<td></td>
</tr>
<tr>
<td>Step 2</td>
<td>Required: install commit</td>
<td>Commits the current set of packages on the router so that these packages are used if the router is restarted.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Command or Action

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>RP/0/RSP0/CPU0:router(admin)# install commit</td>
<td>• This command can be used from either administration EXEC or EXEC mode.</td>
</tr>
</tbody>
</table>

### Step 3

show install committed [detail | summary | verbose] [location node-id]

**Example:**

RP/0/RSP0/CPU0:router(admin)# show install committed

Displays which packages are committed.

• Enter this command in administration EXEC mode to display information for the entire system.

• Enter this command in EXEC mode to display information for a specific SDR only.

• For more information on the command options, see System Management Command Reference for Cisco ASR 9000 Series Routers.

---

### Examples

**Committing the Active Package Set: Example**

In the following example, the active software packages are committed on the router:

RP/0/RSP0/CPU0:router(admin)# install commit

Install operation 16 'install commit' started by user 'lab' at 19:18:58 UTC Sat Apr 08 2009.
Install operation 16 completed successfully at 19:19:01 UTC Sat Apr 08 2009.

**Displaying the Committed Package Versions: Example**

In the following example, the committed packages are shown for the owner SDR:

RP/0/RSP0/CPU0:router(admin)# show install committed

Tue Jun 23 05:11:29.968 PST
Secure Domain Router: Owner

Node 0/RSP0/CPU0 [RP] [SDR: Owner]
Boot Device: disk0:
Boot Image: /disk0/asr9k-os-mbi-3.9.0.12I/mbiasr9k-rp.vm
Committed Packages:
disk0:comp-asr9k-mini-3.9.0.12I
disk0:asr9k-fpd-3.9.0.12I
disk0:asr9k-k9sec-3.9.0.12I
disk0:asr9k-mcast-3.9.0.12I
disk0:asr9k-mgbl-3.9.0.12I
disk0:asr9k-mpls-3.9.0.12I

Node 0/1/CPU0 [LC] [SDR: Owner]
Boot Device: mem:
Boot Image: /disk0/asr9k-os-mbi-3.9.0.12I/lc/mbiasr9k-lc.vm
Committed Packages:
disk0:comp-asr9k-mini-3.9.0.12I
disk0:asr9k-fpd-3.9.0.12I
disk0:asr9k-mcast-3.9.0.12I
disk0:asr9k-mgbl-3.9.0.12I
disk0:asr9k-mpls-3.9.0.12I
As with the `show install active` command, the `show install committed` command may display a composite package that represents all packages in the Cisco IOS XR Unicast Routing Core Bundle.

**Upgrading to Cisco IOS XR Software Release 4.0**

The main difference between the standard upgrade procedure and the procedure required to upgrade from Release 3.x to 4.x is that the later requires the addition of one additional software package, known as the *upgrade package* (asr9k-upgrade-p.pie).

**Before you begin**

Before performing this procedure, refer to the adding and activating software package procedures described in *System Management Configuration Guide for Cisco ASR 9000 Series Routers*.

**SUMMARY STEPS**

1. admin
2. install add tftp://hostname_or_ipaddress/directory-path/mandatory-bundle-pie
3. install add tftp://hostname_or_ipaddress/directory-path/asr9k-upgrade-p.pie
4. install activate device:mandatory-bundle-pie device:upgrade-package
5. install deactivate device:upgrade-package
6. (Optional) install commit
7. install remove device:upgrade-package

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td>Enters administration EXEC mode.</td>
</tr>
<tr>
<td>Required: admin</td>
<td>- From administration EXEC mode, you can perform installation operations for the entire system. To enter administration EXEC mode, you must be logged in to the owner SDR and have root-system access privileges.</td>
</tr>
</tbody>
</table>

**Example:**

RP/0/RSP0/CPU0# admin
### Command or Action

<table>
<thead>
<tr>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>• This command is not required.</td>
</tr>
<tr>
<td>Note Some show install commands can be entered in EXEC mode on an SDR.</td>
</tr>
</tbody>
</table>

### Step 2
**install add tftp://hostname_or_ipaddress/directory-path/mandatory-bundle-pie**

**Example:**

RP/0/RSP0/CPU0:router(admin)# install add tftp://10.1.1.1/auto/tftpboot/usr/400/asr9k-mini-p.pie

Unpacks the mandatory bundle PIE file from a network server and adds the package file to the boot device of the router.

**Note** Refer to the standard procedure to add and activate packages to see other options of PIE file locations and a description of the various arguments for the `install add` command.

### Step 3
**install add tftp://hostname_or_ipaddress/directory-path/asr9k-upgrade-p.pie**

**Example:**

RP/0/RSP0/CPU0:router(admin)# install add tftp://10.1.1.1/auto/tftpboot/usr/400/asr9k-upgrade-p.pie

Unpacks the upgrade PIE file from a network server and adds the package file to the boot device of the router.

### Step 4
**install activate device:mandatory-bundle-pie**

**Example:**

RP/0/RSP0/CPU0:router(admin)# install activate disk0:asr9k-mini-p-4.0.0
disk0:asr9k-upgrade-p-4.0.0

Activates the package that was added to the router together with the upgrade package.

**Note** The bundle of mandatory packages and the upgrade bundle are activated together to perform the successful upgrade from release 3.x to 4.x.

### Step 5
**install deactivate device:upgrade-package**

**Example:**

RP/0/RSP0/CPU0:router(admin)# install deactivate disk0:asr9k-upgrade-p-4.0.0

Deactivates the upgrade package on the router. For specific information regarding the deactivation and removal of software packages, refer to the general procedure.

### Step 6
(Optional) **install commit**

**Example:**

RP/0/RSP0/CPU0:router(admin)# install commit

Commits the current set of packages so that these packages are used if the router is restarted. Packages can be removed only if the deactivation operation is committed.

### Step 7
Required: **install remove device:upgrade-package**

**Example:**

RP/0/RSP0/CPU0:router(admin)# install remove disk0:asr9k-upgrade-p-4.0.0

Removes the inactive upgrade package.

### Example

The following example illustrates the upgrade operation:
RP/0/RSP0/CPU0:router# install add /tftp://223.255.254.254/auto/tftpboot/users/user/asr9k-mini-p.pie
Fri Jul 9 03:53:11.052 UTC
RP/0/RP1/CPU0: Jul 9 03:53:12.053:
instdir[235]: %INSTALL-INSTMGR-6-INSTALL_OPERATION_STARTED:
Install operation 4 '(admin) install add
/tftp://223.255.254.254/auto/tftpboot/users/user/asr9k-mini-p.pie' started by user 'lab'
Install operation 4 '(admin) install add
The install operation will continue asynchronously.
RP/0/RSP0/CPU0:router# install add /tftp://223.255.254.254/auto/tftpboot/users/user/asr9k-mpls-p.pie
Fri Jul 9 05:07:52.237 UTC
RP/0/RP1/CPU0: Jul 9 05:07:53.710:
instdir[235]: %INSTALL-INSTMGR-6-INSTALL_OPERATION_STARTED:
Info: Install operation 5 '(admin) install add /tftp://223.255.254.254/auto/tftpboot/users/user/asr9k-mpls-p.pie' started by user 'lab'
Info: The install operation will continue asynchronously.
RP/0/RSP0/CPU0:router# install add /tftp://223.255.254.254/auto/tftpboot/users/user/asr9k-upgrade-p.pie
Fri Jul 9 05:10:31.133 UTC
RP/0/RP1/CPU0: Jul 9 05:10:32.156:
instdir[235]: %INSTALL-INSTMGR-6-INSTALL_OPERATION_STARTED:
Info: Install operation 6 '(admin) install add /tftp://223.255.254.254/auto/tftpboot/users/user/asr9k-upgrade-p.pie' started by user 'lab'
Info: The install operation will continue asynchronously.
RP/0/RSP0/CPU0:router# install activate disk0:asr9k-mini-p-4.0.0
disk0:asr9k-upgrade-p-4.0.0 disk0:asr9k-mpls-p-4.0.0

System Management Configuration Guide for Cisco ASR 9000 Series Routers, IOS XR Release 6.2.x
Fri Jul 9 05:23:23.150 UTC
Install operation 7 `(admin) install activate disk0:asr9k-mini-p-4.0.0
Info: disk0:asr9k-upgrade-p-4.0.0 disk0:asr9k-pls-p-4.0.0'
Info: started by user 'lab'
RP/0/RP1/CPU0:Jul 9 05:23:24.161 : instdir[235]:
%INSTALL-INSTHELPER-6-RELOAD_NODE_INFO :
Info: As part of install operation 7 this node (0/SM0/SP) will now reload.
Info: The changes made to software configurations will not be persistent
Info: across system reloads. Use the command '(admin) install commit' to
Info: make changes persistent.
Info: Please verify that the system is consistent following the software
RP/0/RP1/CPU0:Jul 9 05:36:43.962 : instdir[235]:
%INSTALL-INSTHELPER-6-RELOAD_NODE_INFO :
Info: As part of install operation 7 this node (0/SM0/SP) will now reload.
Info: The changes made to software configurations will not be persistent
Info: across system reloads. Use the command '(admin) install commit' to
Info: make changes persistent.
Info: Please verify that the system is consistent following the software
Copyright (c) 1994-2009 by Cisco Systems, Inc.
Acquiring backplane mastership ... successful
Preparing for fan initialization........... ready
Setting fan speed to 4000 RPMs successful
Released backplane mastership ...Board type is 0x100002 (1048576)
Switch 0 initialized
Switch 0 Port fe1: link up (100Mb Full Duplex Copper)
Enabling watchdog
Our MAC address is 0005.9a3e.89da
Interface link changed state to UP.
MBI validation sending request.
CARD_RACK_NUMBER: 0  CARD_SLOT_NUMBER: 1  CPU_INSTANCE: 1
RACK_SERIAL_NUMBER: TBC08052402
MBI Validation starts ... using Control Plane Ethernet.
DEBUG : Driving up signal strength for Intel LXT971
Our MAC address is 0005.9a3e.89da
Interface link changed state to UP.
Interface link state up.
MBI validation sending request.
HIT CTRL-C to abort
MBI validation sending request.
HIT CTRL-C to abort
MBI validation sending request.
HIT CTRL-C to abort
MBI validation sending request.
HIT CTRL-C to abort
No MBI confirmation received from dSCboot: booting from
bootflash:disk0/asr9k-os-mbi-4.0.0/mbiasr9k-rp.vm

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Data and Computer
Software clause at DFARS sec. 252.227-7013.
cisco Systems, Inc.
170 West Tasman Drive
San Jose, California 95134-1706
Cisco IOS XR Software for the Cisco XR Router, Version 4.0.0 Copyright (c) 2010 by Cisco
Systems, Inc.
Jul 09 05:39:21.334 : Install (Node Preparation): Booting with software activated by previous
install
operation,errno=2
RP/0/RP1/CPU0:Jul 9 05:44:45.941: syslogd_helper: [89]: dsc_event_handler: Got SysMgr dSC
event : 1
RP/0/RP1/CPU0:Jul 9 05:45:11.354 : shelfmgr[306]: %PLATFORM-SHELFMGR-3-POWERDOWN_RESET :
Node 0/2/SP is powered off due to admin power off request ios con0/RP1/CPU0 is now available
Press RETURN to get started.
RP/0/RP1/CPU0:Jul 9 05:45:27.453 : instdir[216]:
%INSTALL-INSTMGR-4-ACTIVE_SOFTWARE_COMMITTED_INFO :
The currently active software is not committed. If the system reboots then the committed
software will be used.
Use 'install commit' to commit the active software. SYSTEM CONFIGURATION IN PROCESS
The startup configuration for this device is presently loading.
This may take a few minutes. You will be notified upon completion.
Please do not attempt to reconfigure the device until this process is complete.
User Access Verification
Username: lab
Password:
RP/0/RSP0/CPU0:router# admin
Fri Jul 9 05:45:55.941 UTC
RP/0/RSP0/CPU0:router(admin)# show platform
Fri Jul 9 05:45:59.805 UTC
Node Type PLIM State
Config State
--------------------------------------------------------------------------------------------------------
0/2/SP MSC(SP) N/A UNPOWERED NPWR,NSHUT,MON
0/RP1/CPU0 RP(Active) N/A IOS XR RUN PWR,NSHUT,MON
0/SM0/SP FC-40G/S(SP) N/A MBI-RUNNING PWR,NSHUT,MON
0/SM1/* UNKNOWN N/A PRESENT PWR,NSHUT,MON
RP/0/RP1/CPU0:ios(admin)#
RP/0/RP1/CPU0:Jul 9 05:46:08.411 : instdir_lr[217]:
%INSTALL-INSTMGR-4-ACTIVE_SOFTWARE_COMMITTED_INFO :
The currently active software is not committed. If the system reboots then the committed
software will be used.
Use 'install commit' to commit the active software.
RP/0/RP1/CPU0:Jul 9 05:50:40.918 : placed[283]: LR-PLANE-READY DECLARATIONSYSTEM
CONFIGURATION COMPLETED
RP/0/RP1/CPU0:Jul 9 05:50:57.293 : ifmgr[213]: %PKT_INFRA-LINK-3-UPDOWN :
Interface MgmtEth0/RP1/CPU0/0, changed state to Down
RP/0/RP1/CPU0:Jul 9 05:50:57.313 : ifmgr[213]: %PKT_INFRA-LINK-3-UPDOWN :
  Interface MgmtEth0/RP1/CPU0/0, changed state to Up
RP/0/RSP0/CPU0:router (admin) # show platform
Fri Jul 9 05:59:36.266 UTC
<table>
<thead>
<tr>
<th>Node</th>
<th>Type</th>
<th>PLIM</th>
<th>State</th>
<th>Config State</th>
</tr>
</thead>
<tbody>
<tr>
<td>0/2/SP</td>
<td>MSC(SP)</td>
<td>N/A</td>
<td>UNPOWERED</td>
<td>NPWR,NSSHUT,MON</td>
</tr>
<tr>
<td>0/RP1/CPU0</td>
<td>RP(Active)</td>
<td>N/A</td>
<td>IOS XR RUN</td>
<td>PWR,NSSHUT,MON</td>
</tr>
<tr>
<td>0/SM0/SP</td>
<td>FC-40G/S(SP)</td>
<td>N/A</td>
<td>IOS XR RUN</td>
<td>PWR,NSSHUT,MON</td>
</tr>
<tr>
<td>0/SM1/*</td>
<td>UNKNOWN</td>
<td>N/A</td>
<td>PRESENT</td>
<td>PWR,NSSHUT,MON</td>
</tr>
</tbody>
</table>
RP/0/RSP0/CPU0:router (admin) # install commit
Fri Jul 9 05:59:41.851 UTC
Install operation 8 '(admin) install commit' started by user 'lab' via CLI at 05:59:43 UTC Fri Jul 09 2010.
20% complete: The operation can no longer be aborted (ctrl-c for options)
20% complete: The operation can no longer be aborted (ctrl-c for options)
100% complete:
The operation can no longer be aborted (ctrl-c for options)
RP/0/RP1/CPU0:Jul 9 05:59:46.402 : instdir[216]:
%INSTALL-INSTMGR-4-ACTIVE_SOFTWARE_COMMITTED_INFO :
The currently active software is now the same as the committed software.
Install operation 8 completed successfully at 05:59:46 UTC Fri Jul 09 2010.
RP/0/RSP0/CPU0:router (admin) # install deactivate disk0:
asr9k-upgrade-p-4.0.0
Fri Jul 9 05:59:58.082 UTC
Install operation 9 '(admin) install deactivate disk0:asr9k-upgrade-p-4.0.0' started by user 'lab' via CLI at 05:59:59 UTC Fri Jul 09 2010.
1% complete: The operation can still be aborted (ctrl-c for options)
1% complete: The operation can still be aborted (ctrl-c for options)
Info: Install Method: Parallel Process Restart
1% complete: The operation can still be aborted (ctrl-c for options)
The install operation will continue asynchronously.
RP/0/RSP0/CPU0:router (admin) #
Info: The changes made to software configurations will not be persistent
Info: across system reloads. Use the command '(admin) install commit' to
Info: make changes persistent.
Info: Please verify that the system is consistent following the software
Info: change using the following commands:
Info: show system verify
Info: install verify packages
RP/0/RP1/CPU0:Jul 9 06:01:45.662 : instdir[216]:
%INSTALL-INSTMGR-4-ACTIVE_SOFTWARE_COMMITTED_INFO :
The currently active software is not committed. If the system reboots then the committed
software will be used.
Use 'install commit' to commit the active software.
Install operation 9 completed successfully at 06:01:45 UTC Fri Jul 09 2010.
RP/0/RSP0/CPU0:router (admin) # install commit
Fri Jul 9 06:01:53.583 UTC
Install operation 10 '(admin) install commit' started by user 'lab' via CLI at 06:01:54 UTC Fri Jul 09 2010.
20% complete: The operation can no longer be aborted (ctrl-c for options)
20% complete: The operation can no longer be aborted (ctrl-c for options)
100% complete: The operation can no longer be aborted (ctrl-c for options)
RP/0/RP1/CPU0:Jul 9 06:01:57.807 : instdir[216]:
%INSTALL-INSTMGR-4-ACTIVE_SOFTWARE_COMMITTED_INFO :
The currently active software is now the same as the committed software.
Install operation 10 completed successfully at 06:01:57 UTC Fri Jul 09 2010.
Deactivating and Removing Cisco IOS XR Software Packages

When a package is deactivated, it is no longer active on the router, but the package files remain on the boot disk. The package files can be reactivated later, or they can be removed from the disk.

A package is deactivated using the following methods:
When a newer version of a package is activated, the earlier version of the package is automatically deactivated. See Related Topics for more information.

Note
Activating a software maintenance upgrade (SMU) does not cause any earlier SMUs or the package to which the SMU applies to be automatically deactivated.

When an earlier version of a package is activated, the newer version is deactivated automatically. See Related Topics for more information.

A specific package is deactivated using the install deactivate command. This command turns off the package features for a card or card type.

Before you begin
The following are the restrictions when deactivating and removing Cisco IOS XR Software packages:

- A package cannot be deleted if it is part of the running or committed software of the SDR.
- A package cannot be deactivated if that package is required by another active package. When a deactivation is attempted, the system runs an automatic check to ensure that the package is not required by other active packages. The deactivation is permitted only after all compatibility checks have been passed.
- Router reloads: If the deactivation requires a router reload, a confirmation prompt appears. Use the install deactivate command with the prompt-level none keywords to automatically ignore any reload confirmation prompts and proceed with the package deactivation. The router reloads if required.
- Node reloads: If a software operation requires a node reload, the configuration register for that node should be set to autoboot. If the config-register for the node is not set to autoboot, then the system automatically changes the setting and the node reloads. A message describing the change is displayed.
- 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 field-programmable gate array (FPGA) may not operate properly until the incompatibility is resolved. For information on FPDs, including instructions to upgrade FPD images, see the Upgrading FPD Cisco IOS XR Software module of Interface and Hardware Component Configuration Guide for Cisco ASR 9000 Series Routers.

SUMMARY STEPS

1. Connect to the console port and log in.
2. admin
3. install deactivate { id add-id | device : package } [ location node-id ] [ test ] [ pause sw-change ]
4. (Optional) show install inactive summary
5. (Optional) install verify packages
6. exit
7. (Optional) show system verify start
8. (Optional) show system verify [ detail | report ]
9. admin
10. (Optional) install commit
11. (Optional) install remove { id add-id | device : package | inactive } [ test ]
## DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td>Establishes a CLI management session with the SDR. Connect to the console port for the active DSC. For more information on console connections, see Cisco ASR 9000 Series Aggregation Services Router Getting Started Guide.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
</table>
| **Step 2** | Enters administration EXEC mode.  
- From administration EXEC mode, you can perform installation operations for the router. To enter administration EXEC mode, you must be logged in to the owner SDR and have root-system access privileges.  
- This command is not required. |

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
</table>
| **Step 3** | Deactivates a package on a router.  
- To deactivate all packages that were added in one or more specific install add operations, or specify packages by name, use the `id add-id` keyword and argument. The operation ID of an install add operation is indicated in the syslog displayed during the operation and in the output of the `show install log` command.  
- To deactivate a package for the router, use this command in administration EXEC mode.  
- To deactivate a package when logged in to an SDR, use this command in EXEC mode.  
- Use the `location node-id` keyword and argument to deactivate the package for a specific node, if supported.  
- Use the `pause sw-change` keywords to pause the operation after preparatory checks and before the configuration is locked for the actual deactivation. This enables you to hold the operation while you perform configuration changes, and proceed with the deactivation whenever you choose. This is useful, for example, if your workflow involves configuring a router out of the network during software changes and you want to minimize the time that the router is out of the network. Follow the onscreen instructions to control the pausing and completion of the operation. |

### Example:

**Step 2**
```
RP/0/RSP0/CPU0:router# admin
```

**Step 3**
```
install deactivate { id add-id | device : package } [ location node-id ][ test ] [ pause sw-change ]
```

**Example:**
```
RP/0/RSP0/CPU0:router(admin)# install deactivate
disk0:asr9k-diags-3.7.2
```
<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
</table>
| **Step 4**       | **Purpose**  
| (Optional) *show install inactive summary* | Displays the inactive packages on the router. |
| Example:         |         |
| `RP/0/RSP0/CPU0:router(admin)# show install inactive summary` |         |
| **Step 5**       | **Purpose**  
| (Optional) *install verify packages* | Verifies the consistency of an installed software set with the package file from which it originated. This command can be used as a debugging tool to verify the validity of the files that constitute the packages, to determine if there are any corrupted files. This command also checks for corruptions of installation state files and MBI image files. This command is particularly useful when issued after the activation of a package or upgrading the Cisco IOS XR software to a major release. |
| Example:         |         |
| `RP/0/RSP0/CPU0:router(admin)# install verify packages` |         |
| **Step 6**       | **Purpose**  
| Required: *exit* | Exits administration EXEC mode and returns to EXEC mode. |
| Example:         |         |
| `RP/0/RSP0/CPU0:router(admin)# exit` |         |
| **Step 7**       | **Purpose**  
| (Optional) *show system verify start* | Starts the system status check. |
| Example:         |         |
| `RP/0/RSP0/CPU0:router# show system verify start` |         |
| **Step 8**       | **Purpose**  
| (Optional) *show system verify [detail | report]* | Displays system status information. A variety of information is displayed including the memory and CPU usage, process status, protocol status, and other status information. Use this information to verify that the system is stable. |
| Example:         |         |
| `RP/0/RSP0/CPU0:router# show system verify` |         |

**Note**: The *install verify packages* command can take up to two minutes per package to process.
<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>• report — Displays the same information as the default <code>show system verify</code> command</td>
<td></td>
</tr>
<tr>
<td><strong>Note</strong> Although most of the output should display the status “OK,” some processes may show other output, such as “Warning.” This does not specifically indicate a problem. Contact your Cisco technical support representative for more information on the output of this command.</td>
<td></td>
</tr>
</tbody>
</table>

**Step 9**
admin

Example:

RP/0/RSP0/CPU0:router# admin

Enters administration EXEC mode.

**Step 10**
(Optional) install commit

Example:

RP/0/RSP0/CPU0:router(admin)# install commit

Commits the current set of packages so that these packages are used if the router is restarted. Packages can be removed only if the deactivation operation is committed.

**Note** This command is entered in administration EXEC or EXEC mode.

**Step 11**
(Optional) install remove { id add-id | device : package | inactive } [ test ]

Example:

RP/0/RSP0/CPU0:router(admin)# install remove disk0:asr9k-diags-3.8.30

Removes the inactive package.

- Only inactive packages can be removed.
- Packages can be removed only if they are deactivated from all cards in the router.
- The package deactivation must be committed.
- To remove a specific inactive package from a storage device, use the `install remove` command with the `device` `package` arguments.
- To remove all packages that were added in one or more specific `install add` operations, use the `id add-id` keyword and argument. The operation ID of an `install add` operation is indicated in the syslog displayed during the operation and in the output of the `show install log` command. If you specify packages according to operation ID, all the packages that were added by the specified operation must still be on the router.
- To remove all inactive packages from all nodes in the system, use the `install remove` command with the `inactive` keyword.
- You can use the `install remove` command in either administration EXEC or EXEC mode.

**Related Topics**

Adding and Activating Packages, on page 188
Examples

In the following examples, a package is deactivated from the router. The changes are committed and the inactive package is removed from the router.

Deactivating the Package: Example

```
RP/0/RSP0/CPU0:router(admin)# install deactivate disk0:asr9k-diags-3.7.2
```

Install operation 27 'install deactivate disk0:asr9k-diags-3.7.2' started by user 'lab' at 23:29:37 UTC Sat Apr 15 2009.
The install operation will continue asynchronously.
Info: The changes made to software configuration
Info: across system reloads. Use the command 'admin install commit' to make
Info: changes persistent.
Info: Please verify that the system is consistent following the software
Info: change using the following commands:
Info: show system verify
Info: install verify packages
Install operation 27 completed successfully at 23:30:22 UTC Sat Apr 15 2009.

Committing the Active Software Set: Example

```
RP/0/RSP0/CPU0:router(admin)# install commit
```

Install operation 29 'install commit' started by user 'lab' at 23:39:21 UTC Sat Apr 15 2009.

Displaying the Inactive Packages: Example

```
RP/0/RSP0/CPU0:router(admin)# show install inactive summary
```

Default Profile:
SDRs:
Owner
Inactive Packages:
disk0:asr9k-diags-3.7.2

Removing the Inactive Package from the Router: Example

The following example shows how to remove an inactive package. In this example, the operation is run in test mode. The operation is confirmed and the package is removed.

```
RP/0/RSP0/CPU0:router(admin)# install remove disk0:asr9k-diags-3.7.2 test
```

Install operation 30 'install remove disk0:asr9k-diags-3.7.2 test' started by user 'lab' at 23:40:22 UTC Sat Apr 15 2009.
Warning: No changes will occur due to 'test' option being specified. The
Warning: following is the predicted output for this install command.
Info: This operation will remove the following package:
Info: disk0:asr9k-diags-3.7.2
Info: After this install remove the following install rollback points will
Info: no longer be reachable, as the required packages will not be present:
Info: 4, 9, 10, 14, 15, 17, 18
Proceed with removing these packages? [confirm] y

The install operation will continue asynchronously.
Install operation 30 completed successfully at 23.

Pausing Before Configuration Lock: Example

The following example shows how to deactivate a package, pausing the operation before locking the configuration for the actual software deactivation. While the operation is paused, you can enter a configuration mode and perform configurations. When you want to complete the operation, enter the install operation id complete command, or the install operation id attach synchronous command.

RP/0/RSP0/CPU0:router(admin)# install deactivate disk0:comp-asr9k
-3.7.2.07I.CSCsr09575-1.0.0 pause sw-change

Install operation 12 ' (admin) install deactivate
disk0:comp-asr9k-3.7.2.07I.CSCsr09575-1.0.0 pause sw-change' 
started by user 'admin' via CLI at 09:06:26 BST Mon Jul 07 2009.
Info: This operation will reload the following nodes in parallel:
Info: 0/0/CPU0 (RP) (SDR: Owner)
Info: 0/1/CPU0 (LC(E3-GE-4)) (SDR: Owner)
Info: 0/5/CPU0 (LC(E3-OC3-POS-4)) (SDR: Owner)
Proceed with this install operation (y/n)? [y]
The install operation will continue asynchronously.
Info: Install Method: Parallel Reload
Info: Install operation 12 is pausing before the config lock is applied for
Info: the software change as requested by the user.
Info: No further install operations will be allowed until the operation is resumed.
Info: Please continue the operation using one of the following steps:
Info: - run the command ' (admin) install operation 12 complete'.
Info: - run the command ' (admin) install operation 12 attach synchronous' and then
Info: answer the query.

Rolling Back to a Previous Software Set

Cisco IOS XR software allows you to roll back one or more SDRs to a previous committed or uncommitted software set. Use the show install rollback ? command to view the available rollback points and use the install rollback to command to roll back the SDR to a previous software set. You can also use the install rollback to committed command to roll back to the most recent committed software set.

Note
Rollback operations can be performed by running the command in administration EXEC or EXEC mode.

Displaying Rollback Points

A rollback point is created every time a software package is activated, deactivated, or committed. Use the show install rollback ? command to display the eligible rollback points.
Displaying the Active Packages Associated with a Rollback Point

To display the active packages associated with a rollback point, use the `show install rollback` command with the `point-id` argument. This command displays the packages that are active if you roll back one or more SDRs to that installation point. For example, the `show install rollback 2` command displays the packages that are active if you roll back to rollback point 2.

```
RP/0/RSP0/CPU0:router (admin) # show install rollback 0
Tue Jun 23 06:25:06.493 PST
ID: 0, Label:
Secure Domain Router: Owner
  Node 0/RSP0/CPU0 [RP] [SDR: Owner]
    Boot Device: disk0:
    Boot Image: /disk0/scr9k-os-mbi-3.9.0.12I/mbiasr9k-rp.vm
    Rollback Packages:
      disk0:comp-asr9k-mini-3.9.0.12I
  Node 0/1/CPU0 [LC] [SDR: Owner]
    Boot Device: mem:
    Boot Image: /disk0/scr9k-os-mbi-3.9.0.12I/lc/mbiasr9k-lc.vm
    Rollback Packages:
      disk0:comp-asr9k-mini-3.9.0.12I
  Node 0/4/CPU0 [LC] [SDR: Owner]
    Boot Device: mem:
    Boot Image: /disk0/scr9k-os-mbi-3.9.0.12I/lc/mbiasr9k-lc.vm
    Rollback Packages:
      disk0:comp-asr9k-mini-3.9.0.12I
  Node 0/6/CPU0 [LC] [SDR: Owner]
    Boot Device: mem:
    Boot Image: /disk0/scr9k-os-mbi-3.9.0.12I/lc/mbiasr9k-lc.vm
    Rollback Packages:
      disk0:comp-asr9k-mini-3.9.0.12I
```

You can enter the command in either administration EXEC mode or EXEC mode.
Note

For more information on the command options, see the Software Package Management Commands on Cisco IOS XR Software module of System Management Command Reference for Cisco ASR 9000 Series Routers.

Rolling Back to a Specific Rollback Point

You can roll back to a specific rollback point, including a noncommitted software set:

• If you roll back to the most recent noncommitted rollback point (with the highest number), you do not need to reload the router.
• You can repeat the rollback process one rollback point at a time without reloading if you always choose the most recent rollback point.
• If you choose a rollback point that is older than the most recent point, the impacted nodes reload, interrupting data traffic on those nodes. Before the reload occurs, you are prompted to confirm the install rollback operation.

In the following example, the system is rolled back to noncommitted rollback point 8:

RP/0/RSP0/CPU0:router(admin)# install rollback to 8

Install operation 10 'install rollback to 8' started by user 'cisco' at 07:49:26 UTC Mon Nov 14 2009.
The install operation will continue asynchronously.
Info: The changes made to software configurations will not be persistent
Info: across system reloads. Use the command 'admin install commit' to make
Info: changes persistent.
Info: Please verify that the system is consistent following the software
Info: change using the following commands:
Info: show system verify
Info: install verify packages

The currently active software is the same as the committed software.

Install operation 10 completed successfully at 07:51:24 UTC Mon Nov 14 2009.

Rolling Back to the Last Committed Package Set

Use the install rollback to committed command to roll back to the last committed package set.

In the following example, the owner SDR is rolled back to the last committed package set:

RP/0/RSP0/CPU0:router(admin)# install rollback to committed

Install operation 27 'install rollback to committed' started by user 'lab' at 16:41:38 UTC Sat Nov 19 2009.
Info: The rollback to committed software will require a reload of impacted
Info: nodes because it is over multiple activation & deactivation
Info: operations.
Info: This operation will reload the following node:
Info: 0/RP1/CPU0 (RP) (SDR: Owner)
Info: This operation will reload all RPs in the Owner SDR, and thereby
Info: indirectly cause every node in the router to reload.

Proceed with this install operation? [confirm]
Updating Commit Database. Please wait...[OK]
Info: The changes made to software configurations will not be persistent
Info: across system reloads. Use the command 'admin install commit' to make
Info: changes persistent.
Info: Please verify that the system is consistent following the software
Info: change using the following commands:
Info: show system verify
Info: install verify packages

You can enter the command in either administration EXEC mode or EXEC mode.

Additional References

The following sections provide references related to software package management on Cisco IOS XR software.

Related Documents

<table>
<thead>
<tr>
<th>Related Topic</th>
<th>Document Title</th>
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</thead>
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<tr>
<td>Cisco IOS XR install commands</td>
<td>Software Package Management Commands on the Cisco ASR 9000 Series Router module of System Management Command Reference for Cisco ASR 9000 Series Routers</td>
</tr>
<tr>
<td>Cisco IOS XR getting started material</td>
<td>Cisco ASR 9000 Series Aggregation Services Router Getting Started Guide</td>
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<tr>
<td>Cisco IOS XR master command index</td>
<td>Cisco ASR 9000 Series Aggregation Services Router Commands Master List</td>
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<tr>
<td>Information about user groups and task IDs</td>
<td>Configuring AAA Services on the Cisco ASR 9000 Series Router module of System Security Configuration Guide for Cisco ASR 9000 Series Routers</td>
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<tr>
<td>ROM Monitor</td>
<td>ROM Monitor Configuration Guide for Cisco ASR 9000 Routers</td>
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Standards

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<th>Standards</th>
<th>Title</th>
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<tr>
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<td>—</td>
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MIBs

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<tr>
<th>MIBs</th>
<th>MIBs Link</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>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: <a href="http://cisco.com/public/sw-center/netmgmt/cmtk/mibs.shtml">http://cisco.com/public/sw-center/netmgmt/cmtk/mibs.shtml</a></td>
</tr>
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</table>
RFCs

<table>
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<th>Title</th>
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Technical Assistance

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<tr>
<th>Description</th>
<th>Link</th>
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<tbody>
<tr>
<td>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.</td>
<td><a href="http://www.cisco.com/cisco/web/support/index.html">http://www.cisco.com/cisco/web/support/index.html</a></td>
</tr>
</tbody>
</table>
CHAPTER 12

Upgrading Field-Programmable Devices

In general terms, *field-programmable devices* (FPDs) are hardware devices implemented on router cards that support separate software upgrades. A *field-programmable gate array* (FPGA) is a type of programmable memory device that exists on most hardware components of the router. The term *FPD* has been introduced to collectively and generically describe any type of programmable hardware device on SIPS and shared port adapters (SPAs), including FPGAs. Cisco IOS XR software provides the Cisco FPD upgrade feature to manage the upgrade of FPD images on SIPS and SPAs.

This chapter describes the information that you must know to verify image versions and to perform an upgrade for SPA or SIP FPD images when incompatibilities arise.

For complete descriptions of the FPD commands listed in this module, refer to the upcoming sections. To locate documentation for other commands that might appear in the course of performing a configuration task, search online in *Cisco ASR 9000 Series Aggregation Services Router Commands Master List*.

<table>
<thead>
<tr>
<th>Release</th>
<th>Modification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Release 3.9.0</td>
<td>Support for FPD upgrades was introduced.</td>
</tr>
<tr>
<td>Release 5.3.2</td>
<td>Enhance FPD upgrade and downgrade behavior.</td>
</tr>
</tbody>
</table>

This module contains the following topics:

- Prerequisites for FPD Image Upgrades, on page 217
- Overview of FPD Image Upgrade Support, on page 218
- How to Upgrade FPD Images, on page 219
- Configuration Examples for FPD Image Upgrade, on page 223
- Troubleshooting Problems with FPD Image Upgrades, on page 251

**Prerequisites for FPD Image Upgrades**

Before upgrading the FPD on your router you must install and activate the fpd.pie.
Overview of FPD Image Upgrade Support

An FPD image is used to upgrade the software on an FPD.

Whenever an image is released that supports SIPs and SPAs, a companion SIP and SPA FPD image is bundled. Generally, the FPD image is not automatically upgraded. You must manually upgrade the FPD image running on the SPA or SIP when you upgrade the Cisco IOS XR software image.

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. An FPGA incompatibility on a SPA does not necessarily affect the running of the SPA interfaces; an FPD incompatibility on a SIP disables all interfaces for all SPAs in the SIP until the incompatibility is addressed.

Use the `show hw-module fpd` command to determine if an FPD upgrade is required. A value of ‘Yes’ in the Upg/Dng? (upgrade/downgrade) column indicates that an upgrade or downgrade is required.

The Cisco ASR 9000 Series Router supports upgrades for FPGA devices on its SIPs and SPAs. FPGA and ROMMON software upgrades are part of an FPD image package that corresponds to a Cisco IOS XR software image. SIPs and SPAs support manual upgrades for FPGA devices using the Cisco FPD upgrade feature that is further described in this chapter.

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).

Automatic FPD Upgrade

Restriction: Newly inserted or reloaded line cards do not reload automatically after a FPD image automatic upgrade, so you must reload the line card manually to use the new FPD image.

By default, the FPD image is not automatically upgraded. You must manually upgrade the FPD image running on the Field Replaceable Unit (FRU) when you upgrade the Cisco IOS XR software image.

However, if you enable the `fpd auto-upgrade` command in Admin Configuration mode, FPD images are automatically updated when:

- Software upgrade is carried out.
- Line cards are added to an existing router or reloaded.

The following conditions must be met for an Automatic FPD Upgrade to work on a system upgrade:

- FPD package installation envelope (PIE) must be installed on the router.
- FPD PIE must be activated together with the new Cisco IOS XR image.
- The `fpd auto-upgrade` command must be configured in the Admin Configuration mode.

The following conditions must be met for an Automatic FPD Upgrade to work on a FRU Insertion or reload:

- FPD PIE must be installed and activated on the router.
- The `fpd auto-upgrade` command must be configured in the Admin Configuration mode.
Although the FPD upgrade is performed during the install operation, there is no install commit performed. Therefore, once the FPD has been upgraded, if the image is rolled back to the original version, the FPD version is not downgraded to the previous version.

Automatic FPD Upgrade is not performed when:

- A non-reload software maintenance upgrade (SMU) or PIE installation is performed, even where the FPD image version changes. Since a non-reload installation is, by definition, not supposed to reload the router, and an FPD upgrade requires a router reload, an Automatic FPD Upgrade is repressed.

In all cases where the automatic FPD upgrade is not performed, you must perform a manual FPD upgrade using the `upgrade hw-module fpd` command.

A message is displayed when router modules cannot get upgraded during automatic FPD upgrade 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`.

CFP2-DCO Optical modules do not support automatic-FPD upgrade.

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:

- You migrate the software to a later Cisco IOS XR software release.
- You swap SPAs or SIPs from a system running a different Cisco IOS XR software release.
- You insert a new SPA or SIP.

In the event that there is an FPD incompatibility with your card, you may receive an error message. If you upgrade to a newer version of the Cisco IOS XR software and there is an FPD incompatibility, you receive the following message:

```
LC/0/1/CPU0:Dec 23 16:33:47.945 : spa_192_jacket_v2[203]: %PLATFORM-UPGRADE_FPD-4-DOWN_REV : spa fpga2 instance 0 is down-rev (V0.6), upgrade to (V1.0). Use the "upgrade hw-module fpd" CLI in admin mode.
```

If the FPD image on the card is newer then what is required by the currently running Cisco IOS XR software image on the router, you receive the following error message:

```
LC/0/1/CPU0:Dec 23 16:33:47.955 : spa_192_jacket_v2[203]: %PLATFORM-UPGRADE_FPD-4-UP_REV : spa fpga instance 1 is up-rev(V1.10), downgrade to (V0.09) is "OPTIONAL". Use "upgrade hw-module fpd force" CLI in admin mode.
```
You should perform the FPD upgrade procedure if you receive such messages. Cards may not function properly if FPD incompatibilities are not resolved.

An error message is displayed (as shown below) when version-34 of FPGA is upgraded to version-37. This is only for CRS-X linecards. However, when the user upgrades to version-37, from any other lower version (other than version-34), this failure message is not displayed. Even though we see this failure message, FPD upgrade will complete successfully and after a power cycle/reload it will properly reflect the upgraded version. There is no functionality impact.

Note

The use of the `force` option when performing a FPD upgrade is not recommended except under explicit direction from Cisco engineering or TAC.

Before you begin

- Before upgrading the FPD, you must install and activate the asr9k-fpd.pie. For information about performing this task, see the Upgrading and Managing Cisco IOS XR Software module.

- 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 automatically reload the card, you can use the `hw-module reload` command during your 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.

SUMMARY STEPS

1. `show hw-module fpd location {all | node-id}`
2. `admin`
3. (Optional) `show fpd package`
4. `upgrade hw-module fpd {all | fpga-type} [force] location {all | node-id}`
5. `exit`
6. (Optional) `hw-module {location node-id | subslot subslot-id} reload`
7. `show platform`
## DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
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</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> show hw-module fpd location {all</td>
<td>node-id}</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>RP/0/RSP0/CPU0:router# show hw-module fpd location all</td>
<td></td>
</tr>
<tr>
<td>or</td>
<td></td>
</tr>
<tr>
<td>RP/0/RSP0/CPU0:router# show hw-module fpd location 0/4/cpu0</td>
<td></td>
</tr>
<tr>
<td><strong>Step 2</strong> admin</td>
<td>Enters administration EXEC mode.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>RP/0/RSP0/CPU0:router# admin</td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong> (Optional) show fpd package</td>
<td>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.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>RP/0/RSP0/CPU0:router(admin)# show fpd package</td>
<td></td>
</tr>
<tr>
<td><strong>Step 4</strong> upgrade hw-module fpd  {all</td>
<td>fpga-type</td>
</tr>
<tr>
<td>Before continuing to the next step, wait for confirmation that the FPD upgrade has successfully completed. Status messages, similar to these, are displayed to the screen until the FPD upgrade is completed:</td>
<td></td>
</tr>
<tr>
<td>RP/0/RSP0/CPU0:router(admin)# upgrade hw-module fpd all location 0/3/1</td>
<td></td>
</tr>
<tr>
<td>.</td>
<td></td>
</tr>
<tr>
<td>.</td>
<td></td>
</tr>
<tr>
<td>Successfully upgraded 1 FPD for SPA-2XOC48POS/RPR on location 0/3/1</td>
<td></td>
</tr>
<tr>
<td>RP/0/RP0/CPU0:V3_DC_MT(admin)# upgrade hw-module fpd all location all</td>
<td></td>
</tr>
<tr>
<td>RP/0/RP0/CPU0:May 14 22:06:38.715 : upgrade_fpd_cli[65878] : %PLATFORM-UPGRADE_FPD-6-STATUS_UPG_LOC_ALL_OPT : pm fpga11 instance 14 on location 0/RP0/CPU0 was intentionally skipped during upgrade using location all option</td>
<td></td>
</tr>
<tr>
<td>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.</td>
<td></td>
</tr>
<tr>
<td>Command or Action</td>
<td>Purpose</td>
</tr>
<tr>
<td>-------------------</td>
<td>---------</td>
</tr>
<tr>
<td></td>
<td>If Ctrl-C is pressed while the FPD upgrade is in progress, the following warning message is displayed:</td>
</tr>
<tr>
<td></td>
<td>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)]</td>
</tr>
<tr>
<td></td>
<td>If you confirm that you want to abort the FPD upgrade procedure, this message is displayed:</td>
</tr>
<tr>
<td></td>
<td>FPD upgrade process has been aborted, please check the status of the hardware and reissue the upgrade command if required.</td>
</tr>
<tr>
<td></td>
<td>If your card supports multiple FPD images, you can use the <code>show fpd package</code> admin command to determine what specific image to upgrade in the <code>upgrade hw-module fpd</code> command.</td>
</tr>
<tr>
<td></td>
<td>A message is displayed when router modules cannot get upgraded during upgrade with <code>location all</code> 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, <code>upgrade hw-module fpd all location 0/3/1</code>.</td>
</tr>
</tbody>
</table>

**Step 5**  
**Example:**  
RP/0/RSP0/CPU0:router(admin)# exit  
Exits administration EXEC mode and returns to EXEC mode.

**Step 6**  
(Optional) **hw-module** {location node-id | subslot subslot-id} reload  
**Example:**  
RP/0/RSP0/CPU0:router# hw-module subslot 0/3/1 reload  
or  
RP/0/RSP0/CPU0:router# hw-module location 0/3/cpu0 reload  
Use the `hw-module subslot reload` command to reload a SPA and the `hw-module location reload` command to reload a SIP or line card.
### Purpose

Command or Action | Purpose
---|---
**Step 7** | **show platform**
Example: | | RP/0/RSP0/CPU0:router# show platform

Verifies that the FPD image on the card has been successfully upgraded by displaying the status of all cards in the system.

---

### Configuration Examples for FPD Image Upgrade

The following examples indicate the use of commands associated with the FPD image upgrade procedure.

#### show hw-module fpd Command Output: Example

Use the `show hw-module fpd` to display the current version of FPD images on the SPAs, SIPs and other cards installed on your router.

This command can be used to identify information about FPDs on any card. If you enter the location of a line card that is not a SPA, the output displays information about any programmable devices on that line card.

The following example shows how to display FPD compatibility for all modules in the router:

**RP/0/RSP0/CPU0:router# show hw-module fpd location all**

<table>
<thead>
<tr>
<th>Location</th>
<th>Card Type</th>
<th>HW Current SW Upg/</th>
<th>Subtype</th>
<th>Inst</th>
<th>Version</th>
<th>Type</th>
<th>Dng?</th>
</tr>
</thead>
<tbody>
<tr>
<td>0/RSP0/CPU0</td>
<td>A9K-RSP-4G</td>
<td>1.0 lc fpga3</td>
<td>0</td>
<td>1.23</td>
<td>Yes</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>fpga1</td>
<td>0</td>
<td>1.05</td>
<td>No</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>fpga2</td>
<td>0</td>
<td>3.08*</td>
<td>No</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0/0/0</td>
<td>SPA-2XCHOC12/DS0</td>
<td>1.0 spa rommon</td>
<td>0</td>
<td>2.02</td>
<td>No</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>spa fpga</td>
<td>0</td>
<td>1.36+</td>
<td>No</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>spa fpga2</td>
<td>0</td>
<td>1.00*</td>
<td>No</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**NOTES:**

1. One or more FPD needs an upgrade or a downgrade. This can be accomplished using the "admin upgrade hw-module fpd" CLI.
2. * One or more FPD is running minimum software version supported. It can be upgraded using the "admin> upgrade hw-module fpd <fpd> force location <loc>" CLI.
3. + One or more FPD is running up-rev FPGA version. Downgrade is "OPTIONAL" in this case.
4. **"** One or more FPD will be intentionally skipped from upgrade using CLI with option "all" or during "Auto fpd". It can be upgraded only using the "admin> upgrade hw-module fpd <fpd> location <loc>" CLI with exact location.
After Release 5.3.x, Upg/Dng? will display Yes only for upgrade.

The following example shows the FPD for which upgrade will be skipped.

```
RP/0/RP0/CPU0:router# show hw-module fpd location all
```

<table>
<thead>
<tr>
<th>Location</th>
<th>Card Type</th>
<th>HW Version</th>
<th>Type</th>
<th>Subtype</th>
<th>Inst</th>
<th>Current SW</th>
<th>Upg/ Dng?</th>
</tr>
</thead>
<tbody>
<tr>
<td>0/SM1/SP</td>
<td>140G-4-S1S2S3</td>
<td>0.1</td>
<td>lc</td>
<td>rommonA</td>
<td>0</td>
<td>2.08</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1c</td>
<td>common</td>
<td>0</td>
<td>2.08</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>1c</td>
<td>fpqa1</td>
<td>0</td>
<td>6.04^</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>1c</td>
<td>fpqa2</td>
<td>0</td>
<td>4.01</td>
<td>No</td>
<td></td>
</tr>
</tbody>
</table>

**NOTES:**
1. ^ One or more FPD will be intentionally skipped from upgrade using CLI with option "all" or during "Auto fpd".
   It can be upgraded only using the "admin> upgrade hw-module fpd <fpd> location <loc>" CLI with exact location.

**BPID nodes can be used as location to display the BPID image information:**

```
RP/0/RSP0/CPU0:router# sh hw-module fpd location 0/bpid0/sp
```

<table>
<thead>
<tr>
<th>Location</th>
<th>Card Type</th>
<th>HW Version</th>
<th>Type</th>
<th>Subtype</th>
<th>Inst</th>
<th>Current SW</th>
<th>Upg/ Dng?</th>
</tr>
</thead>
<tbody>
<tr>
<td>0/BPID0/SP</td>
<td>ASR-9912-BPID2</td>
<td>1.0</td>
<td>bp</td>
<td>cbc</td>
<td>11</td>
<td>7.104</td>
<td>No</td>
</tr>
</tbody>
</table>

The following example shows how to display FPD compatibility for a specific module in the router:

```
RP/0/RSP1/CPU0:router# show hw-module fpd location 0/4/cpu0
```

```
Thu Nov 19 21:43:49.599 UTC
```

<table>
<thead>
<tr>
<th>Location</th>
<th>Card Type</th>
<th>HW Version</th>
<th>Type</th>
<th>Subtype</th>
<th>Inst</th>
<th>Current SW</th>
<th>Upg/ Dng?</th>
</tr>
</thead>
<tbody>
<tr>
<td>0/4/CPU0</td>
<td>A9K-SIP-700</td>
<td>1.13</td>
<td>lc</td>
<td>fpqa1</td>
<td>0</td>
<td>0.22</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1c</td>
<td>cbc</td>
<td>0</td>
<td>3.03</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>1c</td>
<td>hsbi</td>
<td>0</td>
<td>3.00</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>1c</td>
<td>rommon</td>
<td>0</td>
<td>1.02</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>1c</td>
<td>fpqa2</td>
<td>0</td>
<td>5.14</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>1c</td>
<td>cpld1</td>
<td>0</td>
<td>0.14</td>
<td>No</td>
<td></td>
</tr>
</tbody>
</table>
### Table 30: `show hw-module fpd` Field Descriptions

<table>
<thead>
<tr>
<th>Field</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location</td>
<td>Location of the module in the <code>rack/slot/module</code> notation.</td>
</tr>
<tr>
<td>Card Type</td>
<td>Module part number.</td>
</tr>
<tr>
<td>HW Version</td>
<td>Hardware model version for the module.</td>
</tr>
<tr>
<td>Type</td>
<td>Hardware type. Can be one of the following types:</td>
</tr>
<tr>
<td></td>
<td>• spa—Shared port adapter</td>
</tr>
<tr>
<td></td>
<td>• lc—Line card</td>
</tr>
<tr>
<td>Subtype</td>
<td>FPD type. Can be one of the following types:</td>
</tr>
<tr>
<td></td>
<td>• fabldr—Fabric downloader</td>
</tr>
<tr>
<td></td>
<td>• fpga1—Field-programmable gate array</td>
</tr>
<tr>
<td></td>
<td>• fpga2—Field-programmable gate array 2</td>
</tr>
<tr>
<td></td>
<td>• fpga3—Field-programmable gate array 3</td>
</tr>
<tr>
<td></td>
<td>• fpga4—Field-programmable gate array 4</td>
</tr>
<tr>
<td></td>
<td>• fpga5—Field-programmable gate array 5</td>
</tr>
<tr>
<td></td>
<td>• rommonA—Read-only memory monitor A</td>
</tr>
<tr>
<td></td>
<td>• rommon—Read-only memory monitor B</td>
</tr>
<tr>
<td>Inst</td>
<td>FPD instance. The FPD instance uniquely identifies an FPD and is used by the FPD process to register an FPD.</td>
</tr>
<tr>
<td>Current SW Version</td>
<td>Currently running FPD image version.</td>
</tr>
<tr>
<td>Upg/Dng?</td>
<td>Specifies whether an FPD upgrade or downgrade is required. A downgrade is required in rare cases when the version of the FPD image has a higher major revision than the version of the FPD image in the current Cisco IOS XR software package.</td>
</tr>
</tbody>
</table>

### show fpd package Command Output: Example

Use the `show fpd package` command in administration EXEC mode to find out which SPAs and SIPs are supported with your current Cisco IOS XR software release, which FPD image package you need for each SPA or SIP, 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.

The following example shows sample output from the `show fpd package` command:

```
RP/0/RP1/CPU0:router(admin)# show fpd package

Thu Jul 7 04:34:48.351 DST

Field Programmable Device Package

<table>
<thead>
<tr>
<th>Card Type</th>
<th>FPD Description</th>
<th>Type Subtype</th>
<th>Version</th>
<th>SW Ver</th>
<th>HW Vers</th>
</tr>
</thead>
</table>

```

System Management Configuration Guide for Cisco ASR 9000 Series Routers, IOS XR Release 6.2.x
### show fpd package Command Output: Example

<table>
<thead>
<tr>
<th>Model</th>
<th>Component</th>
<th>Type</th>
<th>Vendor</th>
<th>Version</th>
<th>Type</th>
<th>Status</th>
<th>Status</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>A9K-40GE-B</td>
<td>Can Bus Ctrl (CBC) LC2</td>
<td>lc</td>
<td>cbc</td>
<td>2.02</td>
<td>0.0</td>
<td>0.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>CPUCtrl LC2</td>
<td>lc</td>
<td>cpld1</td>
<td>1.00</td>
<td>0.0</td>
<td>0.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>PHYCtrl LC2</td>
<td>lc</td>
<td>cpld2</td>
<td>0.06</td>
<td>0.0</td>
<td>0.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>PortCtrl LC2</td>
<td>lc</td>
<td>fpga2</td>
<td>0.10</td>
<td>0.0</td>
<td>0.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bridge LC2</td>
<td>lc</td>
<td>fpga1</td>
<td>0.43</td>
<td>0.0</td>
<td>0.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>ROMMONA LC2</td>
<td>lc</td>
<td>rommonA</td>
<td>1.05</td>
<td>0.0</td>
<td>0.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>ROMMONB LC2</td>
<td>lc</td>
<td>rommon</td>
<td>1.05</td>
<td>0.0</td>
<td>0.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A9K-4T-B</td>
<td>Can Bus Ctrl (CBC) LC2</td>
<td>lc</td>
<td>cbc</td>
<td>2.02</td>
<td>0.0</td>
<td>0.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>CPUCtrl LC2</td>
<td>lc</td>
<td>cpld1</td>
<td>1.00</td>
<td>0.0</td>
<td>0.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>PHYCtrl LC2</td>
<td>lc</td>
<td>cpld2</td>
<td>0.08</td>
<td>0.0</td>
<td>0.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>LCClkCtrl LC2</td>
<td>lc</td>
<td>cpld3</td>
<td>0.03</td>
<td>0.0</td>
<td>0.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>PortCtrl LC2</td>
<td>lc</td>
<td>fpga2</td>
<td>0.10</td>
<td>0.0</td>
<td>0.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>PHY LC2</td>
<td>lc</td>
<td>fpga3</td>
<td>14.44</td>
<td>0.0</td>
<td>0.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bridge LC2</td>
<td>lc</td>
<td>fpga1</td>
<td>0.43</td>
<td>0.0</td>
<td>0.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>ROMMONB LC2</td>
<td>lc</td>
<td>rommon</td>
<td>1.05</td>
<td>0.0</td>
<td>0.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A9K-8T/4-B</td>
<td>Can Bus Ctrl (CBC) LC2</td>
<td>lc</td>
<td>cbc</td>
<td>2.02</td>
<td>0.0</td>
<td>0.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>CPUCtrl LC2</td>
<td>lc</td>
<td>cpld1</td>
<td>1.00</td>
<td>0.0</td>
<td>0.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>PHYCtrl LC2</td>
<td>lc</td>
<td>cpld2</td>
<td>0.08</td>
<td>0.0</td>
<td>0.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>LCClkCtrl LC2</td>
<td>lc</td>
<td>cpld3</td>
<td>0.03</td>
<td>0.0</td>
<td>0.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>PortCtrl LC2</td>
<td>lc</td>
<td>fpga2</td>
<td>0.10</td>
<td>0.0</td>
<td>0.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>PHY LC2</td>
<td>lc</td>
<td>fpga3</td>
<td>14.44</td>
<td>0.0</td>
<td>0.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bridge LC2</td>
<td>lc</td>
<td>fpga1</td>
<td>0.43</td>
<td>0.0</td>
<td>0.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>ROMMONB LC2</td>
<td>lc</td>
<td>rommon</td>
<td>1.05</td>
<td>0.0</td>
<td>0.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A9K-2T20GE-B</td>
<td>Can Bus Ctrl (CBC) LC2</td>
<td>lc</td>
<td>cbc</td>
<td>2.02</td>
<td>0.0</td>
<td>0.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>CPUCtrl LC2</td>
<td>lc</td>
<td>cpld1</td>
<td>1.00</td>
<td>0.0</td>
<td>0.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>PHYCtrl LC2</td>
<td>lc</td>
<td>cpld2</td>
<td>0.11</td>
<td>0.0</td>
<td>0.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>LCClkCtrl LC2</td>
<td>lc</td>
<td>cpld3</td>
<td>0.09</td>
<td>0.0</td>
<td>0.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>PortCtrl LC2</td>
<td>lc</td>
<td>fpga2</td>
<td>0.16</td>
<td>0.0</td>
<td>0.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bridge LC2</td>
<td>lc</td>
<td>fpga1</td>
<td>0.43</td>
<td>0.0</td>
<td>0.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>ROMMONB LC2</td>
<td>lc</td>
<td>rommon</td>
<td>1.05</td>
<td>0.0</td>
<td>0.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Model</td>
<td>Description</td>
<td>LC</td>
<td>ROM 1</td>
<td>ROM 2</td>
<td>ROM 3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
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</table>
This table describes the significant fields shown in the display:

**Table 31: show fpd package Field Descriptions**

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<th>Field</th>
<th>Description</th>
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<td>Card Type</td>
<td>Module part number.</td>
</tr>
<tr>
<td>FPD Description</td>
<td>Description of all FPD images available for the SPA.</td>
</tr>
<tr>
<td>Type</td>
<td>Hardware type. Possible types can be:</td>
</tr>
<tr>
<td></td>
<td>• spa—Shared port adapter</td>
</tr>
<tr>
<td></td>
<td>• lc—Line card</td>
</tr>
<tr>
<td>Subtype</td>
<td>FPD subtype. These values are used in the <code>upgrade hw-module fpd</code> command to indicate a specific FPD image type to upgrade.</td>
</tr>
<tr>
<td>SW Version</td>
<td>FPD software version recommended for the associated module running the current Cisco IOS XR software.</td>
</tr>
<tr>
<td>Min Req SW Vers</td>
<td>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.</td>
</tr>
</tbody>
</table>
### Field Programmable Device Package

<table>
<thead>
<tr>
<th>Card Type</th>
<th>FPD Description</th>
<th>Type</th>
<th>Subtype</th>
<th>SW Version</th>
<th>Min Req SW Ver</th>
<th>Min Req HW Vers</th>
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This example shows the output display for ASR9912 and ASR9922:

```
RP/0/RSP0/CPU0:router # show fpd package
```

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.
<table>
<thead>
<tr>
<th>System Management Configuration Guide for Cisco ASR 9000 Series Routers, IOS XR Release 6.2.x</th>
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| LCClkCtrl LC2| l | 0.03 | 0.00 | 0.1 |
| PortCtrl LC2 | l | 0.10 | 0.00 | 0.1 |
| PHY LC2      | l | 14.44 | 0.00 | 0.1 |
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| ROMMONB LC2  | l | 1.05 | 0.00 | 0.1 |

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| LCClkCtrl LC2| l | 0.03 | 0.00 | 0.1 |
| PortCtrl LC2 | l | 0.10 | 0.00 | 0.1 |
| PHY LC2      | l | 14.44 | 0.00 | 0.1 |
| Bridge LC2   | l | 0.44 | 0.00 | 0.1 |
| ROMMONB LC2  | l | 1.05 | 0.00 | 0.1 |

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**System Management Configuration Guide for Cisco ASR 9000 Series Routers, IOS XR Release 6.2.x**

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A9K-ISM-100

- Can Bus Ctrl (CBC) LC6 | lc cbc | 18.06 | 0.00 | 0.1 |
- CPUCtrl LC6           | lc cpld1 | 0.01 | 0.00 | 0.1 |
- Maintenance LC6       | lc fpga2 | 2.13 | 0.00 | 0.1 |
- Amistad LC6           | lc fpga1 | 0.33 | 0.00 | 0.20 |
- ROMMONB LC6           | lc rommon | 1.02 | 0.00 | 0.1 |

A9K-RSP-3G

- ClockCtrl RSP3       | lc fpga2 | 1.06 | 0.00 | 0.1 |
- UTI RSP3             | lc fpga3 | 4.09 | 0.00 | 0.1 |
- CPUCtrl RSP3         | lc fpga1 | 0.09 | 0.00 | 0.1 |
- ROMMONB RSP3         | lc rommon | 0.70 | 0.00 | 0.1 |

A9K-RSP-24G

- ClockCtrl RSP3       | lc fpga2 | 1.06 | 0.00 | 0.1 |
- UTI RSP3             | lc fpga3 | 4.09 | 0.00 | 0.1 |
- CPUCtrl RSP3         | lc fpga1 | 0.09 | 0.00 | 0.1 |
- ROMMONB RSP3         | lc rommon | 0.70 | 0.00 | 0.1 |

SPA-4XT3/E3

- SPA E3 Subrate FPGA  | spa fpga2 | 1.04 | 0.00 | 0.0 |
- SPA T3 Subrate FPGA  | spa fpga3 | 1.04 | 0.00 | 0.0 |
- SPA I/O FPGA         | spa fpga1 | 1.01 | 0.00 | 0.0 |
- SPA ROMMON           | spa rommon | 2.12 | 0.00 | 0.0 |

SPA-4XCT3/DS0

- SPA T3 Subrate FPGA  | spa fpga2 | 0.11 | 0.00 | 0.100 |
- SPA T3 Subrate FPGA  | spa fpga2 | 1.04 | 0.00 | 0.200 |
- SPA I/O FPGA         | spa fpga1 | 2.08 | 0.00 | 0.100 |
- SPA ROMMON           | spa rommon | 2.12 | 0.00 | 0.100 |

SPA-1XCHSTM1/OC3

- SPA T3 Subrate FPGA  | spa fpga2 | 1.04 | 0.00 | 0.0 |
- SPA I/O FPGA         | spa fpga1 | 1.08 | 0.00 | 0.0 |
- SPA ROMMON           | spa rommon | 2.12 | 0.00 | 0.0 |
show fpd package Command Output: Example

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<th>0.00</th>
<th>1.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPA I/O FPGA</td>
<td>spa fpga1</td>
<td>2.32</td>
<td>0.00</td>
<td>1.0</td>
<td></td>
</tr>
<tr>
<td>SPA ROMMON</td>
<td>spa rommon</td>
<td>1.03</td>
<td>0.00</td>
<td>1.0</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SPA-2CHT3-CE-ATM</th>
<th>SPA T3 Subrate FPGA</th>
<th>spa fpga2</th>
<th>1.11</th>
<th>0.00</th>
<th>1.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPA I/O FPGA</td>
<td>spa fpga1</td>
<td>2.22</td>
<td>0.00</td>
<td>1.0</td>
<td></td>
</tr>
<tr>
<td>SPA ROMMON</td>
<td>spa rommon</td>
<td>1.04</td>
<td>0.00</td>
<td>1.0</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SPA-1CHOC3-CE-ATM</th>
<th>SPA OC3 Subrate FPGA</th>
<th>spa fpga2</th>
<th>2.23</th>
<th>0.00</th>
<th>0.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPA I/O FPGA</td>
<td>spa fpga1</td>
<td>2.23</td>
<td>0.00</td>
<td>2.0</td>
<td></td>
</tr>
<tr>
<td>SPA ROMMON</td>
<td>spa rommon</td>
<td>1.04</td>
<td>0.00</td>
<td>0.0</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SPA-1XCHOC48/DS3</th>
<th>SPA I/O FPGA</th>
<th>spa fpga2</th>
<th>1.00</th>
<th>0.00</th>
<th>0.49</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPA I/O FPGA</td>
<td>spa fpga3</td>
<td>1.00</td>
<td>0.00</td>
<td>0.52</td>
<td></td>
</tr>
<tr>
<td>SPA I/O FPGA</td>
<td>spa fpga1</td>
<td>1.36</td>
<td>0.00</td>
<td>0.49</td>
<td></td>
</tr>
<tr>
<td>SPA ROMMON</td>
<td>spa rommon</td>
<td>2.02</td>
<td>0.00</td>
<td>0.49</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SPA-2XCHOC12/DS0</th>
<th>SPA FPGA2 swv1.00</th>
<th>spa fpga2</th>
<th>1.00</th>
<th>0.00</th>
<th>0.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPA FPGA swv1.36</td>
<td>spa fpga1</td>
<td>1.36</td>
<td>0.00</td>
<td>0.49</td>
<td></td>
</tr>
<tr>
<td>SPA ROMMON swv2.2</td>
<td>spa rommon</td>
<td>2.02</td>
<td>0.00</td>
<td>0.49</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>A9K-MPA-20X1GE</th>
<th>EP I/O FPGA</th>
<th>spa fpga3</th>
<th>0.08</th>
<th>0.00</th>
<th>0.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>A9K-MPA-2X10GE</td>
<td>EP I/O FPGA</td>
<td>spa fpga6</td>
<td>1.06</td>
<td>0.00</td>
<td>0.0</td>
</tr>
<tr>
<td>A9K-MPA-4X10GE</td>
<td>EP I/O FPGA</td>
<td>spa fpga6</td>
<td>1.06</td>
<td>0.00</td>
<td>0.0</td>
</tr>
<tr>
<td>A9K-MPA-2X40GE</td>
<td>EP Sage</td>
<td>spa fpga7</td>
<td>1.03</td>
<td>0.00</td>
<td>0.0</td>
</tr>
<tr>
<td>A9K-MPA-1X40GE</td>
<td>EP Sage</td>
<td>spa fpga7</td>
<td>1.03</td>
<td>0.00</td>
<td>0.0</td>
</tr>
<tr>
<td>A9K-MPA-8X10GE</td>
<td>EP I/O FPGA</td>
<td>spa fpga8</td>
<td>0.07</td>
<td>0.00</td>
<td>0.0</td>
</tr>
<tr>
<td>SPA-8XOC12-POS</td>
<td>SPA FPGA swv1.0</td>
<td>spa fpga1</td>
<td>1.00</td>
<td>0.00</td>
<td>0.5</td>
</tr>
<tr>
<td>SPA-8XCHT1/E1</td>
<td>SPA I/O FPGA</td>
<td>spa fpga1</td>
<td>2.08</td>
<td>0.00</td>
<td>0.0</td>
</tr>
<tr>
<td>SPA ROMMON</td>
<td>spa rommon</td>
<td>2.12</td>
<td>0.00</td>
<td>0.140</td>
<td></td>
</tr>
<tr>
<td>SPA-OC192POS-XFP</td>
<td>SPA FPGA swv1.2</td>
<td>spa fpga1</td>
<td>1.02</td>
<td>0.00</td>
<td>2.0</td>
</tr>
</tbody>
</table>
This example shows the fpd details of the A9K-MOD400-SE:

```
RP/0/RSP0/CPU0:router # show hw-module fpd location 0/2/CPU0
```

<table>
<thead>
<tr>
<th>Location</th>
<th>Card Type</th>
<th>HW Version</th>
<th>Type</th>
<th>Subtype</th>
<th>Current SW Upg/ Inst</th>
<th>Version</th>
<th>Dng?</th>
</tr>
</thead>
<tbody>
<tr>
<td>0/2/CPU0</td>
<td>A9K-MOD400-SE</td>
<td>1.0</td>
<td>lc</td>
<td>cbc</td>
<td>39.05</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>lc</td>
<td>rommon</td>
<td>8.32</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>lc</td>
<td>fpga2</td>
<td>1.30</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>lc</td>
<td>fsbl</td>
<td>1.19</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>lc</td>
<td>lnxfw</td>
<td>1.20</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>lc</td>
<td>fpga10</td>
<td>1.17</td>
<td>No</td>
<td></td>
</tr>
</tbody>
</table>

This example shows the fpd details of the A9K-MOD400-SE:
In the show fpd package command output, the “subtype” column shows the FPDs that correspond with each SPA image. To upgrade a specific FPD with the upgrade hw-module fpd command, replace the fpga-type argument with the appropriate FPD from the “subtype” column, as shown in the following example:

```
RP/0/RSP0/CPU0:router (admin)# upgrade hw-module fpd fpga2 location 0/3/1 reload
```

**upgrade hw-module fpd Command Output: Example**

Use the upgrade hw-module fpd command to upgrade the FPD image on a SPA, SIP or line card.

```
RP/0/RSP0/CPU0:router# admin
RP/0/RSP0/CPU0:router (admin)# upgrade hw-module fpd fpga location 0/1/cpu0

Mon Jan 12 05:44:37.611 PST
% RELOAD REMINDER: - The upgrade operation of the target module will not interrupt its normal operation. However, for the changes to take effect, the target module will need to be manually reloaded after the upgrade operation. This can be accomplished with the use of "hw-module <target> reload" command. - If automatic reload operation is desired after the upgrade, please use the "reload" option at the end of the upgrade command. - The output of "show hw-module fpd location" command will not display correct version information after the upgrade if the target module is not reloaded.
Continue? [confirm] y

Starting the upgrade/download of following FPD:

```
------------------------------------ ------------------ --------------- -------------------- ---
| Location | Type | Subtype | Upg/Dng | Current Version | Upg/Dng Version |
------------------------------------ ------------------ --------------- -------------------- ---
| 0/1/CPU0 | lc   | fpga    | upg     | 0.40            | 0.40            |
```
```
LC/0/1/CPU0:Jan 12 05:44:43.700 : lc_fpd_upgrade[192]: %PLATFORM-UPGRADE_FPD-6-START :
Starting to upgrade fpga subtype image from 0.4 to 0.4 for for this card on location 0/1/CPU0
SP/0/1/SPI:Jan 12 05:44:41.150 : upgrade_daemon[280]: programming...with file
/net/node0_RP1_CPU0/disk0:/asr9k-fpd-3.9.0.25I/fpd/ucode/fpga_jacket_hw80_sw0.4.xsvf
LC/0/1/CPU0:Jan 12 05:44:42.990 : fabricq_mgr[152]: EES:Internal clock detect IDLE period=-106461 more than threshold(1200000)
LC/0/1/CPU0:Jan 12 05:44:42.990 : ingressq[179]: EES:Internal clock detect IDLE period=-106461 more than threshold(1200000)
LC/0/1/CPU0:Jan 12 05:44:42.990 : fabricq_mgr[152]: EES:Internal clock detect IDLE period=-105945 more than threshold(1200000)
LC/0/1/CPU0:Jan 12 05:44:42.990 : ingressq[179]: EES:Internal clock detect IDLE period=-105945 more than threshold(1200000)
LC/0/1/CPU0:Jan 12 05:45:09.240 : fabricq_mgr[152]: EES:Internal clock detect IDLE period=-105944 more than threshold(1200000)
SP/0/1/SPI:Jan 12 05:45:16.020 : upgrade_daemon[280]: ...programming...
SP/0/1/SPI:Jan 12 05:45:16.034 : upgrade_daemon[280]: ...it will take a while...
SP/0/1/SPI:Jan 12 05:45:16.053 : upgrade_daemon[280]: ...it will take a while...
SP/0/1/SPI:Jan 12 05:47:42.967 : upgrade_daemon[280]: ...programming...
SP/0/1/SPI:Jan 12 05:47:42.981 : upgrade_daemon[280]: ...it will take a while...
% SLC/0/1/CPU0:Jan 12 05:48:08.737 : lc_fpd_upgrade[192]: %PLATFORM-UPGRADE_FPD-6-PASSED :
```

```
System Management Configuration Guide for Cisco ASR 9000 Series Routers, IOS XR Release 6.2.x
250
```
Successfully upgrade fpga subtype image for for this card on location 0/1/CPU0

**show platform Command Output: Example**

Use the `show platform` command to verify that the SPA is up and running.

```
RP/0/RSP0/CPU0# show platform
```

```
Sat Jul 25 12:26:38.905 DST
Node Type State Config State
------------------------------------------
0/RSP0/0 CPU0 A9K-RSP-4G(Active) IOS XR RUN PWR,NSHUT,MON
0/FT0/SP FAN TRAY READY
0/FT1/SP FAN TRAY READY
0/1/CPU0 A9K-40GE-B IOS XR RUN PWR,NSHUT,MON
0/4/CPU0 A9K-4T/4-B IOS XR RUN PWR,NSHUT,MON
0/6/CPU0 A9K-4T-B IOS XR RUN PWR,NSHUT,MON
0/FM0/SP A9K-3KW-AC READY PWR,NSHUT,MON
0/FM1/SP A9K-3KW-AC READY PWR,NSHUT,MON
0/FM2/SP A9K-3KW-AC READY PWR,NSHUT,MON
```

**Troubleshooting Problems with FPD Image Upgrades**

This section contains information to help troubleshoot problems that can occur during the upgrade process.

**Power Failure or Removal of a SPA During an FPD Image Upgrade**

If the FPD upgrade operation is interrupted by a power failure or the removal of the SPA, it could corrupt the FPD image. This corruption of the FPD image file makes the SPA unusable by the router and the system displays the following messages when it tries to power up the SPA. When it cannot successfully power up the SPA, it places it in the failed state, as shown in the following example:

```
LC/0/3/CPU0:Feb 4 08:23:16.672: spa_192_jacket[188]: %L2-SPA-5-OIR_INSERTED: SPA discovered in bay 0
LC/0/3/CPU0:Feb 4 08:23:23.349: spa_192_jacket[188]: %L2-SPA-5-OIR_ERROR : SPA (0): An error occurred (0x1002), error recovery action: reset SPA
LC/0/3/CPU0:Feb 4 08:23:26.431: spa_192_jacket[188]: %L2-SPA-5-OIR_INSERTED: SPA discovered in bay 0
LC/0/3/CPU0:Feb 4 08:23:32.593: spa_192_jacket[188]: %L2-SPA-5-OIR_ERROR : SPA (0): Too many retries, error recovery stopped
LC/0/3/CPU0:Feb 4 08:23:32.593: spa_192_jacket[188]: %L2-SPA-5-OIR_ERROR : SPA (0): An error occurred (0x1002), error recovery action: hold SPA in reset
```

When a SPA is in the failed state, it may not register itself with the FPD upgrade mechanism. In this case, you do not see the SPA listed when you use the `show hw-module fdp` command. To verify the state of a SPA, use the `show hw-module subslot error` command and the `show hw-module subslot status` command.
Performing a SPA FPD Recovery Upgrade

To recover a SPA from the failed state because of a corrupted FPD image, you must manually shut down the SPA. Use the `hw-module subslot subslot-id shutdown` command in Global Configuration mode to administratively shutdown the SPA. After the SPA is shut down, you can use the `upgrade hw-module fpd` command in administration EXEC mode:

```
RP/0/RSP0/CPU0:router# admin
RP/0/RSP0/CPU0:router(admin)# upgrade hw-module fpd fpga location 0/3/0
```

Performing a SIP FPD Recovery Upgrade

If a SIP upgrade fails for whatever reason, do not reload the SIP. Try to perform the upgrade procedure again. You can perform the upgrade procedure multiple times, as long as you do not reload the SIP. The FPD upgrade procedure takes several minutes to complete; do not interrupt the procedure. If you reload the SIP when the FPD image is corrupted, the SIP malfunctions and you must contact Cisco technical support for assistance.

To recover a SIP from the failed state because of a corrupted FPD image, you must contact Cisco technical support.

To recover a SIP from the failed state because of a corrupted FPD image, you must turn off the automatic reset of the SIP card. Use the `hw-module reset auto disable` command in administration configuration mode, as shown in the following example:

```
RP/0/RSP0/CPU0:router(admin-config)# hw-module reset auto disable location 0/1/4
```
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.

This module describes the tasks you need to implement NTP on the Cisco IOS XR software.

For more information about NTP on the Cisco IOS XR software and complete descriptions of the NTP commands listed in this module, see Related Documents, on page 275. To locate documentation for other commands that might appear in the course of running a configuration task, search online in Cisco ASR 9000 Series Aggregation Services Router Commands Master List.

Table 32: Feature History for Implementing NTP on Cisco IOS XR Software

<table>
<thead>
<tr>
<th>Release</th>
<th>Modification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Release 3.7.2</td>
<td>This feature was introduced.</td>
</tr>
<tr>
<td>Release 3.9.0</td>
<td>Support was added for IPv6 addresses, VRFs, multicast-based associations, and burst and iburst modes for poll-based associations.</td>
</tr>
<tr>
<td>Release 4.3.0</td>
<td>Support was added for NTP-PTP interworking.</td>
</tr>
<tr>
<td>Release 4.3.1</td>
<td>Support was added for NTP server inside VRF interface</td>
</tr>
</tbody>
</table>

This module contains the following topics:

- Prerequisites for Implementing NTP on Cisco IOS XR Software, on page 254
- Information About Implementing NTP, on page 254
- How to Implement NTP, on page 255
- Configuration Examples for Implementing NTP, on page 271
- Configuring NTP server inside VRF interface, on page 274
- Additional References, on page 275
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 two ways that a networking device can obtain NTP time information on a network:

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

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

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

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

**NTP-PTP Interworking**

NTP-PTP interworking provides the ability to use PTP, as well as other valid time of day (TOD) sources such as Data over Cable Service Interface Specification (DOCSIS) Timing Interface (DTI) and global positioning system (GPS), as the time source for the operating system. Prior to the support of NTP-PTP interworking, only backplane time was supported for the operating system time.

NTP-PTP interworking also provides the means to communicate status changes between PTP and NTP processes. It also supports the unambiguous control of the operating system time and backplane time in the event of bootup, switchovers or card and process failures.

**Related Topics**

Configuring NTP-PTP Interworking, on page 267

**How to Implement NTP**

**Configuring Poll-Based Associations**

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

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

  - Client mode
  - Symmetric active mode

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

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

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

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

---

**Note**

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

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

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

---

**SUMMARY STEPS**

1. `configure`
2. `ntp`
3. `server ip-address [version number] [key key-id] [minpoll interval] [maxpoll interval] [source type interface-path-id] [prefer] [burst] [iburst]`
4. `peer ip-address [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**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td>configure</td>
</tr>
<tr>
<td><strong>Step 2</strong></td>
<td><code>ntp</code></td>
</tr>
<tr>
<td>Example:</td>
<td><code>RP/0/RSP0/CPU0:router(config)# ntp</code></td>
</tr>
<tr>
<td></td>
<td>Enters NTP configuration mode.</td>
</tr>
<tr>
<td>Command or Action</td>
<td>Purpose</td>
</tr>
<tr>
<td>-------------------</td>
<td>---------</td>
</tr>
<tr>
<td><strong>Step 3</strong></td>
<td><strong>server ip-address [version number] [key key-id] [minpoll interval] [maxpoll interval] [source type interface-path-id] [prefer] [burst] [iburst]</strong> Forms a server association with another system. This step can be repeated as necessary to form associations with multiple devices.</td>
</tr>
<tr>
<td>Example:</td>
<td>RP/0/RSP0/CPU0:router(config-ntp)# server 172.16.22.44 minpoll 8 maxpoll 12</td>
</tr>
</tbody>
</table>

| **Step 4** | **peer ip-address [version number] [key key-id] [minpoll interval] [maxpoll interval] [source type interface-path-id] [prefer]** Forms a peer association with another system. This step can be repeated as necessary to form associations with multiple systems. |
| Example: | RP/0/RSP0/CPU0:router(config-ntp)# peer 192.168.22.33 minpoll 8 maxpoll 12 source tengige 0/0/0/1 |

| **Step 5** | Use one of the following commands: |
| Example: | RP/0/RSP0/CPU0:router(config-ntp)# end or RP/0/RSP0/CPU0:router(config-ntp)# commit |

Saves configuration changes. |
- When you issue the **end** command, the system prompts you to commit changes: |
  Uncommitted changes found, commit them before exiting(yes/no/cancel)? [cancel]: |
  - Entering **yes** saves configuration changes to the running configuration file, exits the configuration session, and returns the router to EXEC mode. |
  - Entering **no** exits the configuration session and returns the router to EXEC mode without committing the configuration changes. |
  - Entering **cancel** leaves the router in the current configuration session without exiting or committing the configuration changes. |
- Use the **commit** command to save the configuration changes to the running configuration file and remain within the configuration session. |

### Configuring Broadcast-Based NTP Associates

In a broadcast-based NTP association, an NTP server propagates NTP broadcast packets throughout a network. Broadcast clients listen for the NTP broadcast packets propagated by the NTP server and do not engage in any polling.
Broadcast-based NTP associations should be used when time accuracy and reliability requirements are modest and if your network is localized and has a large number of clients (more than 20). Broadcast-based NTP associations also are recommended for use on networks that have limited bandwidth, system memory, or CPU resources. Time accuracy is marginally reduced in broadcast-based NTP associations because information flows only one way.

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

Use the broadcast command to set your networking device to send NTP broadcast packets.

---

**Note**

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

---

**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**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> configure</td>
<td>Enters NTP configuration mode.</td>
</tr>
<tr>
<td><strong>Step 2</strong> ntp</td>
<td>Enters NTP configuration mode.</td>
</tr>
<tr>
<td><strong>Example:</strong> RP/0/RSP0/CPU0:router(config)# ntp</td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong> (Optional) broadcastdelay microseconds</td>
<td>Adjusts the estimated round-trip delay for NTP broadcasts.</td>
</tr>
<tr>
<td><strong>Example:</strong> RP/0/RSP0/CPU0:router(config-ntp)# broadcastdelay 5000</td>
<td></td>
</tr>
<tr>
<td><strong>Step 4</strong> interface type interface-path-id</td>
<td>Enters NTP interface configuration mode.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>Command or Action</td>
<td>Purpose</td>
</tr>
<tr>
<td>----------------------------------------------------------------------------------</td>
<td>---------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>RP/0/RSP0/CPU0:router(config-ntp)# interface POS 0/1/0/0</td>
<td>Configures the specified interface to receive NTP broadcast packets.</td>
</tr>
<tr>
<td><strong>Step 5</strong> broadcast client</td>
<td>Configures the specified interface to receive NTP broadcast packets.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>RP/0/RSP0/CPU0:router(config-ntp-int)# broadcast client</td>
<td></td>
</tr>
<tr>
<td><strong>Step 6</strong> broadcast [destination ip-address] [key key-id] [version number]</td>
<td>Configures the specified interface to send NTP broadcast packets.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>RP/0/RSP0/CPU0:router(config-ntp-int)# broadcast destination 10.50.32.149</td>
<td></td>
</tr>
<tr>
<td><strong>Step 7</strong> Use one of the following commands:</td>
<td>Saves configuration changes.</td>
</tr>
<tr>
<td>• end</td>
<td></td>
</tr>
<tr>
<td>• commit</td>
<td></td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>RP/0/RSP0/CPU0:router(config-ntp-int)# end</td>
<td></td>
</tr>
<tr>
<td>or</td>
<td></td>
</tr>
<tr>
<td>RP/0/RSP0/CPU0:router(config-ntp-int)# commit</td>
<td></td>
</tr>
</tbody>
</table>

**Configuring NTP Access Groups**

**Note**

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

The access list-based restriction scheme allows you to grant or deny certain access privileges to an entire network, a subnet within a network, or a host within a subnet.
The access group options are scanned in the following order, from least restrictive to most restrictive:

1. **peer**—Allows time requests and NTP control queries and allows the system to synchronize itself to a system whose address passes the access list criteria.
2. **serve**—Allows time requests and NTP control queries, but does not allow the system to synchronize itself to a system whose address passes the access list criteria.
3. **serve-only**—Allows only time requests from a system whose address passes the access list criteria.
4. **query-only**—Allows only NTP control queries from a system whose address passes the access list criteria.

If the source IP address matches the access lists for more than one access type, the first type is granted. If no access groups are specified, all access types are granted to all systems. If any access groups are specified, only the specified access types are granted.

For details on NTP control queries, see RFC 1305 (NTP version 3).

**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**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td>configure</td>
</tr>
</tbody>
</table>
| **Step 2** | ntp
   - Example: RP/0/RSP0/CPU0:router(config)# ntp |
   - Enters NTP configuration mode. |
| **Step 3** | access-group{peer | query-only | serve | serve-only} access-list-name
   - Example: RP/0/RSP0/CPU0:router(config-ntp)# access-group peer access1 |
   - Creates an access group and applies a basic IPv4 or IPv6 access list to it. |
| **Step 4** | Use one of the following commands:
   - end
   - commit
   - Example: RP/0/RSP0/CPU0:router(config-ntp)# end or |
   - Saves configuration changes.
   - When you issue the **end** command, the system prompts you to commit changes:
     Uncommitted changes found, commit them before
     exiting(yes/no/cancel)? [cancel]: |
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

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
</table>
| RP/0/RSP0/CPU0:router(config-ntp)# commit | • Entering yes saves configuration changes to the running configuration file, exits the configuration session, and returns the router to EXEC mode.
• Entering no exits the configuration session and returns the router to EXEC mode without committing the configuration changes.
• Entering cancel leaves the router in the current configuration session without exiting or committing the configuration changes.
• Use the commit command to save the configuration changes to the running configuration file and remain within the configuration session. |
Configuring NTP Authentication

### DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> configure</td>
<td></td>
</tr>
<tr>
<td><strong>Step 2</strong> ntp</td>
<td>Enters NTP configuration mode.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>RP/0/RSP0/CPU0:router(config)# ntp</td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong> authenticate</td>
<td>Enables the NTP authentication feature.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>RP/0/RSP0/CPU0:router(config-ntp)# authenticate</td>
<td></td>
</tr>
<tr>
<td><strong>Step 4</strong> authentication-key key-number md5 [clear</td>
<td>encrypted]</td>
</tr>
<tr>
<td><strong>key-name</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>RP/0/RSP0/CPU0:router(config-ntp)# authentication-key 42 md5 clear key1</td>
<td></td>
</tr>
<tr>
<td><strong>Step 5</strong> trusted-key key-number</td>
<td>Defines trusted authentication keys.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>RP/0/RSP0/CPU0:router(config-ntp)# trusted-key 42</td>
<td></td>
</tr>
<tr>
<td><strong>Step 6</strong> Use one of the following commands:</td>
<td>Saves configuration changes.</td>
</tr>
<tr>
<td>- end</td>
<td></td>
</tr>
<tr>
<td>- commit</td>
<td></td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>RP/0/RSP0/CPU0:router(config-ntp)# end</td>
<td></td>
</tr>
<tr>
<td>or</td>
<td></td>
</tr>
<tr>
<td>RP/0/RSP0/CPU0:router(config-ntp)# commit</td>
<td></td>
</tr>
</tbody>
</table>

- 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.
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**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
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<td>configure</td>
</tr>
<tr>
<td><strong>Step 2</strong></td>
<td>ntp</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong></td>
<td>Use one of the following commands:</td>
</tr>
<tr>
<td></td>
<td>• no interface type interface-path-id</td>
</tr>
<tr>
<td></td>
<td>• interface type interface-path-id disable</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Step 4</strong></td>
<td>Use one of the following commands:</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

• 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**

<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>configure</td>
<td></td>
</tr>
<tr>
<td>Step</td>
<td>Command or Action</td>
<td>Purpose</td>
</tr>
<tr>
<td>------</td>
<td>------------------</td>
<td>---------</td>
</tr>
<tr>
<td>2</td>
<td>ntp</td>
<td>Enters NTP configuration mode.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>RP/0/RSP0/CPU0:router(config)# ntp</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>source type interface-path-id</td>
<td>Configures an interface from which the IP source address is taken.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>RP/0/RSP0/CPU0:router(config-ntp)# source POS 0/0/0/1</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Use one of the following commands:</td>
<td>Saves configuration changes.</td>
</tr>
<tr>
<td></td>
<td>• end</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• commit</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>RP/0/RSP0/CPU0:router(config-ntp)# end</td>
<td></td>
</tr>
<tr>
<td></td>
<td>or</td>
<td></td>
</tr>
<tr>
<td></td>
<td>RP/0/RSP0/CPU0:router(config-ntp)# commit</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Note</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>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 255.</td>
<td></td>
</tr>
</tbody>
</table>

**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**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1 configure</td>
<td>Enters NTP configuration mode.</td>
</tr>
<tr>
<td>Step 2 ntp</td>
<td>Makes the router an authoritative NTP server.</td>
</tr>
<tr>
<td>Example:</td>
<td>RP/0/RSP0/CPU0:router(config)# ntp</td>
</tr>
<tr>
<td>Step 3 master stratum</td>
<td>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.</td>
</tr>
<tr>
<td>Example:</td>
<td>RP/0/RSP0/CPU0:router(config-ntp)# master 9</td>
</tr>
<tr>
<td>Step 4 Use one of the following commands:</td>
<td>Saves configuration changes.</td>
</tr>
<tr>
<td>• end</td>
<td>• When you issue the end command, the system prompts you to commit changes:</td>
</tr>
</tbody>
</table>
| • commit         | Uncommitted changes found, commit them before exiting(yes/no/cancel)? 
| Example:         | [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. |
|                 | RP/0/RSP0/CPU0:router(config-ntp)# end |
|                 | or |
|                 | RP/0/RSP0/CPU0:router(config-ntp)# commit |
Configuring NTP-PTP Interworking

Use this task to configure NTP to use PTP as the time source.

Before you begin

PTP must be supported and enabled on the router before NTP-PTP interworking can be configured. If PTP is not enabled, you receive an error message similar to the following when you try to commit the configuration:

```
RP/0/RSP0/CPU0:router(config)# ntp master primary-reference-clock
RP/0/RSP0/CPU0:router(config)# commit
% Failed to commit one or more configuration items. Please issue 'show configuration failed' from this session to view the errors
RP/0/RSP0/CPU0:router(config)# show configuration failed
%(:::)
ntp
master primary-reference-clock
!! 'ip-ntp' detected the 'fatal' condition 'PTP is not supported on this platform'
!
end
```

Refer to the Configuring PTP, on page 416 module for more information.

### SUMMARY STEPS

1. configure
2. ntp
3. master primary-reference-clock
4. Use one of the following commands:
   - end
   - commit

### DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> configure</td>
<td>Purpose</td>
</tr>
<tr>
<td><strong>Step 2</strong> ntp</td>
<td>Enters NTP configuration mode.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>RP/0/RSP0/CPU0:router(config)# ntp</td>
<td></td>
</tr>
</tbody>
</table>
### 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:
## DETAILED STEPS

<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
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<td>1</td>
<td>configure</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>ntp</td>
<td>Enters NTP configuration mode.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>RP/0/RSP0/CPU0:router(config)# ntp</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>update-calendar</td>
<td>Configures the router to update its system calendar from the software clock at periodic intervals.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>RP/0/RSP0/CPU0:router(config-ntp)# update-calendar</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Use one of the following commands:</td>
<td>Saves configuration changes.</td>
</tr>
<tr>
<td></td>
<td>• end</td>
<td>• When you issue the <strong>end</strong> command, the system prompts you to commit changes:</td>
</tr>
<tr>
<td></td>
<td>• commit</td>
<td>Uncommitted changes found, commit them before exiting(yes/no/cancel)? (cancel):</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>RP/0/RSP0/CPU0:router(config-ntp)# end</td>
<td></td>
</tr>
<tr>
<td></td>
<td>or</td>
<td></td>
</tr>
<tr>
<td></td>
<td>RP/0/RSP0/CPU0:router(config-ntp)# commit</td>
<td></td>
</tr>
</tbody>
</table>

### Verifying the Status of the External Reference Clock

This task explains how to verify the status of NTP components.
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

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td>Displays the status of NTP associations.</td>
</tr>
<tr>
<td><code>show ntp associations [detail] [location node-id]</code></td>
<td></td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>RP/0/RSP0/CPU0:router# show ntp associations</td>
<td></td>
</tr>
<tr>
<td><strong>Step 2</strong></td>
<td>Displays the status of NTP.</td>
</tr>
<tr>
<td><code>show ntp status [location node-id]</code></td>
<td></td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>RP/0/RSP0/CPU0:router# show ntp status</td>
<td></td>
</tr>
</tbody>
</table>

### Examples

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

```text
RP/0/RSP0/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 (synced), # master (unsynced), + selected, - candidate, ~ configured
```

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

```text
RP/0/RSP0/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:

```plaintext
ntp
  server 10.0.2.1 minpoll 5 maxpoll 7
  peer 192.168.22.33
  server 172.19.69.1
```

**Configuring Broadcast-Based Associations: Example**

The following example shows an NTP client configuration in which interface 0/2/0/0 is configured to receive NTP broadcast packets, and the estimated round-trip delay between an NTP client and an NTP broadcast server is set to 2 microseconds:

```plaintext
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:

```plaintext
ntp
  interface tengige 0/2/0/2
    broadcast
```

**Configuring NTP Access Groups: Example**

The following example shows a NTP access group configuration where the following access group restrictions are applied:

- Peer restrictions are applied to IP addresses that pass the criteria of the access list named peer-acl.
- Serve restrictions are applied to IP addresses that pass the criteria of access list named serve-acl.
- Serve-only restrictions are applied to IP addresses that pass the criteria of the access list named serve-only-acl.
- Query-only restrictions are applied to IP addresses that pass the criteria of the access list named query-only-acl.

```plaintext
ntp
  peer 10.1.1.1
```
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:
Configuring Network Time Protocol

**Example for Implementing NTP**

```plaintext
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:

```plaintext
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:

```plaintext
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:

```plaintext
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

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td>configure</td>
</tr>
<tr>
<td><strong>Step 2</strong></td>
<td>ntp</td>
</tr>
<tr>
<td>Example:</td>
<td>RP/0/RSP0/CPU0:router(config)# ntp</td>
</tr>
<tr>
<td><strong>Step 3</strong></td>
<td>vrf vrf-name</td>
</tr>
<tr>
<td>Example:</td>
<td>RP/0/RSP0/CPU0:router(config)# ntp vrf Customer_A</td>
</tr>
<tr>
<td><strong>Step 4</strong></td>
<td>source interface-type interface-instance</td>
</tr>
<tr>
<td>Example:</td>
<td>RP/0/RSP0/CPU0:router(config)# ntp vrf Customer_A source bvi 70</td>
</tr>
<tr>
<td><strong>Step 5</strong></td>
<td>Use one of the following commands:</td>
</tr>
<tr>
<td>• end</td>
<td>Saves configuration changes.</td>
</tr>
<tr>
<td>• commit</td>
<td>• When you issue the end command, the system prompts you to commit changes:</td>
</tr>
</tbody>
</table>

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 255.
Command or Action | Purpose
--- | ---
Example:
RP/0/RSP0/CPU0:router(config-ntp)# end or
RP/0/RSP0/CPU0:router(config-ntp)# commit

Uncommitted changes found, commit them before exiting (yes/no/cancel)? [cancel]:
- Entering yes saves configuration changes to the running configuration file, exits the configuration session, and returns the router to EXEC mode.
- Entering no exits the configuration session and returns the router to EXEC mode without committing the configuration changes.
- Entering cancel leaves the router in the current configuration session without exiting or committing the configuration changes.
- Use the commit command to save the configuration changes to the running configuration file and remain within the configuration session.

### Additional References

The following sections provide references related to implementing NTP on Cisco IOS XR software.

#### Related Documents

<table>
<thead>
<tr>
<th>Related Topic</th>
<th>Document Title</th>
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</thead>
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<tr>
<td>Cisco IOS XR clock commands</td>
<td>Clock Commands on the Cisco ASR 9000 Series Router module of System Management Command Reference for Cisco ASR 9000 Series Routers</td>
</tr>
<tr>
<td>Cisco IOS XR NTP commands</td>
<td>NTP Commands on module of System Management Command Reference for Cisco ASR 9000 Series Routers</td>
</tr>
<tr>
<td>Information about getting started with Cisco IOS XR Software</td>
<td>Cisco ASR 9000 Series Aggregation Services Router Getting Started Guide</td>
</tr>
<tr>
<td>Cisco IOS XR master command index</td>
<td>Cisco ASR 9000 Series Aggregation Services Router Commands Master List</td>
</tr>
<tr>
<td>Information about user groups and task IDs</td>
<td>Configuring AAA Services on the Cisco ASR 9000 Series Router module of System Security Configuration Guide for Cisco ASR 9000 Series Routers</td>
</tr>
</tbody>
</table>
Standards

<table>
<thead>
<tr>
<th>Standards</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>No new or modified standards are supported by this feature, and support for existing standards has not been modified by this feature.</td>
<td>—</td>
</tr>
</tbody>
</table>

MIBs

<table>
<thead>
<tr>
<th>MIBs</th>
<th>MIBs Link</th>
</tr>
</thead>
<tbody>
<tr>
<td>—</td>
<td>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: <a href="http://cisco.com/public/sw-center/netmgmt/cmtk/mibs.shtml">http://cisco.com/public/sw-center/netmgmt/cmtk/mibs.shtml</a></td>
</tr>
</tbody>
</table>

RFCs

<table>
<thead>
<tr>
<th>RFCs</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>RFC 1059</td>
<td><em>Network Time Protocol, Version 1: Specification and Implementation</em></td>
</tr>
<tr>
<td>RFC 1119</td>
<td><em>Network Time Protocol, Version 2: Specification and Implementation</em></td>
</tr>
<tr>
<td>RFC 1305</td>
<td><em>Network Time Protocol, Version 3: Specification, Implementation, and Analysis</em></td>
</tr>
</tbody>
</table>

Technical Assistance

<table>
<thead>
<tr>
<th>Description</th>
<th>Link</th>
</tr>
</thead>
<tbody>
<tr>
<td>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.</td>
<td><a href="http://www.cisco.com/cisco/web/support/index.html">http://www.cisco.com/cisco/web/support/index.html</a></td>
</tr>
</tbody>
</table>
CHAPTER 14

Configuring Network Configuration Protocol

This module provides details of the Network Configuration Protocol. For relevant commands, see System Security Command Reference for Cisco ASR 9000 Series Routers.

<table>
<thead>
<tr>
<th>Release</th>
<th>Modification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Release 5.3.0</td>
<td>This feature was introduced.</td>
</tr>
<tr>
<td>Release 5.3.1</td>
<td>Support extended for more Yang models.</td>
</tr>
<tr>
<td>Release 6.0</td>
<td>Support extended for the Netconf subsystem configuration to be vrf aware. The configuration of the netconf port is no longer sufficient to start the Netconf subsystem support. At least one vrf needs to be configured. The configuration of the port is now optional.</td>
</tr>
</tbody>
</table>

- The Network Configuration Protocol, on page 277
- Netconf and Yang, on page 279
- Supported Yang Models, on page 280
- Denial of Services Defence for Netconf-Yang, on page 280
- Dynamic Loading of Operational Yang Models, on page 281
- Enabling NETCONF over SSH, on page 281
- Additional Reference, on page 283

The Network Configuration Protocol

The Network Configuration Protocol (Netconf) provides mechanisms to install, manipulate, and delete the configuration of network devices. It uses an Extensible Markup Language (XML)-based data encoding for the configuration data as well as the protocol messages. Yang is a data modeling language used with Netconf.

Netconf uses a simple RPC-based (Remote Procedure Call) mechanism to facilitate communication between a client and a server. The client can be a script or application typically running as part of a network manager. The server is typically a network device.

The configuration of features need not be done the traditional way (using CLIs), the client application (controller) reads the Yang model and communicates with the Netconf server (IOS XR) accordingly.
**Netconf Sessions and Operations**

A Netconf session is the logical connection between a network configuration application and a network device. A device should be capable of supporting multiple sessions and at least one Netconf session.

Characteristics of a Netconf session:

- Netconf is connection-oriented - SSH or TLS can be the underlying transport.
- The Netconf client establishes session with the server.
- Netconf sessions are established with the `hello` message. Features and capabilities are announced.
- Sessions can be terminated using the `close` or `kill` messages.

Basic Netconf operations:

- Get configuration `<get-config>`
- Get all information `<get>`
- Edit configuration `<edit-config>`
- Copy configuration `<copy-config>`

Note: `<copy-config>` does not support source attribute with “data store” at present.

- Delete configuration `<delete-config>`
- `<lock>`, `<unlock>`
- `<kill-session>`
- `<close-session>`
- Commit configuration `<commit>`

**The Yang data model**

Each feature has a defined Yang Model which is synthesized from the schemas. A model is published in a tree format and includes:

- Top level nodes and their subtrees
- Subtrees that augment nodes in other Yang models

Example: The aaa Yang model

```yang
module: Cisco-IOS-XR-aaa-lib-cfg
   +-rw aaa
     +-rw accountings
       |
       |   +-rw accounting* [type listname]
       |
       |     +-rw type xr:Cisco-ios-xr-string
       |
       |     +-rw listname xr:Cisco-ios-xr-string
       |
       |     +-rw rp-failover? Aaa-accounting-rp-failover
       |
       |     +-rw broadcast? Aaa-accounting-broadcast
       |
       |     +-rw type-xr? Aaa-accounting
```

System Management Configuration Guide for Cisco ASR 9000 Series Routers, IOS XR Release 6.2.x
Advantages of using the Yang model are:

- Yang supports programmatic interfaces.
- Yang supports simplified network management applications.
- Yang supports interoperability that provides a standard way to model management data.

**Netconf and Yang**

The workflow displayed here, will help the user to understand how Netconf-Yang can configure and control the network with minimal user intervention. The required components:

- Cisco Router (ASR9000 series or CRS) with Netconf capability
- Netconf Client Application with connection to the router

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Device / component</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Cisco router (ASR 9000 or CRS router)</td>
<td>Login/ access the router.</td>
</tr>
</tbody>
</table>
| 2      | Cisco router | Prerequisites for enabling Netconf.  
- k9sec pie must be installed.  
- Crypto keys must be generated. |
| 3      | Cisco router | Enable Netconf agent. Use the **netconf-yang agent ssh** and **ssh server netconf** command. The port can be selected. By default, it is set as 830. |
| 4      | Cisco router | Yang models are a part of the software image. The models can be retrieved from the router, using the <get-schema> operation. |
**Supported Yang Models**

The Yang models can be downloaded from a prescribed location (ftp server) or can also be retrieved directly from the router using the get-schema operation.

For a feature, separate Yang models are available for configuring the feature and to get operational statistics (show commands). The `-cfg.yang` suffix denotes configuration and `-oper*.yang` is for operational data statistics. In some cases, `-oper` is followed by `-sub`, indicating that a submodule(s) is available.

For a list of supported Yang models, see [https://github.com/YangModels/yang/tree/master/vendor/cisco/xr](https://github.com/YangModels/yang/tree/master/vendor/cisco/xr)

**Denial of Services Defence for Netconf-Yang**

In case of a DoS (Denial of Service) attack on Netconf, wherein, Netconf receives numerous requests in a short span of time, the router may become irresponsive if Netconf consumes most of the bandwidth or CPU processing time. This can be prevented, by limiting the traffic directed at the Netconf agent. This is achieved using the `netconf-yang agent rate-limit` and `netconf-yang agent session` commands.

If rate-limit is set, the Netconf processor measures the incoming traffic from the SSH server. If the incoming traffic exceeds the set rate-limit, the packets are dropped.

If session-limit is set, the Netconf processor checks for the number of open sessions. If the number of current sessions is greater than or equal to, the set limit, no new sessions are opened.

---

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Device / component</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Netconf client (application) &lt;br&gt;The application can be on any standalone application or a SDN controller supporting Netconf</td>
<td>Installs and processes the Yang models. &lt;br&gt;The client can offer a list of supported yang models; else the user will have to browse and locate the required yang file. &lt;br&gt;There is a yang model file for each configuration module; for instance if the user wants to configure CDP, the relevant yang model is Cisco-IOS-XR-cdp-cfg &lt;br&gt;Note Refer the table which lists all the supported yang models. Supported Yang Models , on page 280</td>
</tr>
<tr>
<td>5</td>
<td>Netconf client</td>
<td>Sends Netconf operation request over SSH to the router. A configuration request could include Yang-based XML data to the router. Currently, SSH is the only supported transport method.</td>
</tr>
<tr>
<td>6</td>
<td>Cisco router</td>
<td>Understands the Yang-based XML data and the network is configured accordingly (in case of configuration request from the client). &lt;br&gt;The interactions between the client and the router happens until the network is configured as desired.</td>
</tr>
</tbody>
</table>
Session idle-timeout and absolute-timeout also prevent DoS attacks. The Netconf processor closes the sessions, even without user input or intervention, as soon as the time out session is greater than or equal to the set time limit.

The relevant commands are discussed in detail, in the *System Security Command Reference for Cisco ASR 9000 Series Routers*.

**Dynamic Loading of Operational Yang Models**

Netconf is enhanced to pre-load only the configurational yang models in memory, when it starts. The operational yang models are loaded into memory only when a request is issued. This helps reduce consumption of the RAM memory.

**Enabling NETCONF over SSH**

This task enables NETCONF over SSH. SSH is currently the only supported transport method.

If the client supports, Netconf over ssh can utilize the multi-channeling capabilities of IOS XR ssh server. For additional details about Multi-channeling in SSH, see *Implementing Secure Shell in System Security Configuration Guide*.

**Prerequisites:**

- k9sec pie must be installed, otherwise the port configuration for the netconf ssh server cannot be completed. (The Netconf subsystem for SSH, as well as, SSH cannot be configured without the k9sec pie.)
- Crypto keys must be generated prior to this configuration.
- The Netconf-YANG feature is packaged in the mgbl pie, which must be installed before enabling the Netconf-YANG agent.

**SUMMARY STEPS**

1. `configure`
2. `netconf-yang agent ssh`
3. `ssh server netconf [vrf vrf-name [ipv4 access-list ipv4 access list name] [ipv6 access-list ipv6 access list name]]`
4. `ssh server netconf port port-number`

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> configure</td>
<td>Enables NETCONF agent over SSH connection. After NETCONF is enabled, the Yang model in the controller, can configure the relevant models.</td>
</tr>
<tr>
<td><strong>Step 2</strong> netconf-yang agent ssh</td>
<td>The Yang models can be retrieved from the router via NETCONF &lt;get-schema&gt; operation.</td>
</tr>
<tr>
<td>Example: RP/0/RSP0/CPU0:router (config) # netconf agent ssh</td>
<td>Note</td>
</tr>
</tbody>
</table>
### Examples: Netconf over SSH

This section illustrates some examples relevant to Netconf:

**Enabling netconf-yang for ssh transport and netconf subsystem for default vrf with default port (830)**

```config
cfg netconf-yang agent ssh
cfg ssh server netconf vrf default
!
```

**Enabling netconf-yang for ssh transport and netconf subsystem for vrf green and vrf red with netconf port (831)**

```config
cfg netconf-yang agent ssh
!
cfg ssh server netconf vrf green
cfg ssh server netconf vrf red
cfg ssh server netconf port 831
!
```

---

### What to do next

The `show netconf-yang statistics` command and `show netconf-yang clients` command can be used to verify the configuration details of the Netconf agent.

The `clear netconf-yang agent session` command clears the specified Netconf session (on the Netconf server side).

---

### Examples: Netconf over SSH

This section illustrates some examples relevant to Netconf:

**Enabling netconf-yang for ssh transport and netconf subsystem for default vrf with default port (830)**

```config
cfg netconf-yang agent ssh
cfg ssh server netconf vrf default
!
```

**Enabling netconf-yang for ssh transport and netconf subsystem for vrf green and vrf red with netconf port (831)**

```config
cfg netconf-yang agent ssh
!
cfg ssh server netconf vrf green
cfg ssh server netconf vrf red
cfg ssh server netconf port 831
!
```
**Show command outputs**

show netconf-yang statistics

<table>
<thead>
<tr>
<th>Summary statistics</th>
<th>requests</th>
<th>total time</th>
<th>min time per request</th>
<th>max time per request</th>
<th>avg time per request</th>
</tr>
</thead>
<tbody>
<tr>
<td>other</td>
<td>0</td>
<td>0h 0m 0s 0ms</td>
<td>0h 0m 0s 0ms</td>
<td>0h 0m 0s 0ms</td>
<td>0h 0m 0s 0ms</td>
</tr>
<tr>
<td>close-session</td>
<td>4</td>
<td>0h 0m 0s 3ms</td>
<td>0h 0m 0s 0ms</td>
<td>0h 0m 0s 0ms</td>
<td>0h 0m 0s 0ms</td>
</tr>
<tr>
<td>kill-session</td>
<td>0</td>
<td>0h 0m 0s 0ms</td>
<td>0h 0m 0s 0ms</td>
<td>0h 0m 0s 0ms</td>
<td>0h 0m 0s 0ms</td>
</tr>
<tr>
<td>get-schema</td>
<td>0</td>
<td>0h 0m 0s 0ms</td>
<td>0h 0m 0s 0ms</td>
<td>0h 0m 0s 0ms</td>
<td>0h 0m 0s 0ms</td>
</tr>
<tr>
<td>get</td>
<td>0</td>
<td>0h 0m 0s 0ms</td>
<td>0h 0m 0s 0ms</td>
<td>0h 0m 0s 0ms</td>
<td>0h 0m 0s 0ms</td>
</tr>
<tr>
<td>get-config</td>
<td>1</td>
<td>0h 0m 0s 1ms</td>
<td>0h 0m 0s 0ms</td>
<td>0h 0m 0s 0ms</td>
<td>0h 0m 0s 0ms</td>
</tr>
<tr>
<td>edit-config</td>
<td>3</td>
<td>0h 0m 0s 2ms</td>
<td>0h 0m 0s 0ms</td>
<td>0h 0m 0s 0ms</td>
<td>0h 0m 0s 0ms</td>
</tr>
<tr>
<td>commit</td>
<td>0</td>
<td>0h 0m 0s 0ms</td>
<td>0h 0m 0s 0ms</td>
<td>0h 0m 0s 0ms</td>
<td>0h 0m 0s 0ms</td>
</tr>
<tr>
<td>cancel-commit</td>
<td>0</td>
<td>0h 0m 0s 0ms</td>
<td>0h 0m 0s 0ms</td>
<td>0h 0m 0s 0ms</td>
<td>0h 0m 0s 0ms</td>
</tr>
<tr>
<td>lock</td>
<td>0</td>
<td>0h 0m 0s 0ms</td>
<td>0h 0m 0s 0ms</td>
<td>0h 0m 0s 0ms</td>
<td>0h 0m 0s 0ms</td>
</tr>
<tr>
<td>unlock</td>
<td>0</td>
<td>0h 0m 0s 0ms</td>
<td>0h 0m 0s 0ms</td>
<td>0h 0m 0s 0ms</td>
<td>0h 0m 0s 0ms</td>
</tr>
<tr>
<td>discard-changes</td>
<td>0</td>
<td>0h 0m 0s 0ms</td>
<td>0h 0m 0s 0ms</td>
<td>0h 0m 0s 0ms</td>
<td>0h 0m 0s 0ms</td>
</tr>
<tr>
<td>validate</td>
<td>0</td>
<td>0h 0m 0s 0ms</td>
<td>0h 0m 0s 0ms</td>
<td>0h 0m 0s 0ms</td>
<td>0h 0m 0s 0ms</td>
</tr>
</tbody>
</table>

**show netconf-yang clients**

<table>
<thead>
<tr>
<th>client session ID</th>
<th>NC version</th>
<th>client connect time</th>
<th>last OP time</th>
<th>last OP type</th>
</tr>
</thead>
<tbody>
<tr>
<td>22969</td>
<td>1.1</td>
<td>0d 0h 0m 2s</td>
<td>11:11:24</td>
<td>close-session</td>
</tr>
<tr>
<td>15389</td>
<td>1.1</td>
<td>0d 0h 0m 1s</td>
<td>11:11:25</td>
<td>get-config</td>
</tr>
</tbody>
</table>

**Additional Reference**

**Table 33: Related Documents**

<table>
<thead>
<tr>
<th>Related Topic</th>
<th>Document Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Netconf-Yang</td>
<td>For related commands, see System Security Command Reference for Cisco ASR 9000 Series Routers</td>
</tr>
</tbody>
</table>

**Table 34: Standards**

<table>
<thead>
<tr>
<th>Component</th>
<th>RFCs</th>
</tr>
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<tbody>
<tr>
<td>YANG</td>
<td>6020</td>
</tr>
<tr>
<td>NETCONF</td>
<td>6241</td>
</tr>
</tbody>
</table>
### Component

<table>
<thead>
<tr>
<th>Component</th>
<th>RFCs</th>
</tr>
</thead>
<tbody>
<tr>
<td>NETCONF over SSH</td>
<td>6242</td>
</tr>
</tbody>
</table>

Additional Reference
CHAPTER 15

Configuring Disk Mirroring

This module describes the process to configure disk mirroring in Cisco IOS XR software.

For complete descriptions of the commands listed in this module, see Related Documents, on page 293. To locate documentation for other commands that might appear in the course of performing a configuration task, search online in Cisco ASR 9000 Series Aggregation Services Router Commands Master List.

Table 35: Feature History for Disk Mirroring for Cisco IOS XR Software

<table>
<thead>
<tr>
<th>Release</th>
<th>Modification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Release 3.7.2</td>
<td>Disk mirroring was introduced.</td>
</tr>
<tr>
<td>Release 3.9.0</td>
<td>No modification.</td>
</tr>
</tbody>
</table>

This module contains the following topics:

- Disk Mirroring Prerequisites, on page 285
- Information About Disk Mirroring, on page 286
- How to Enable Disk Mirroring, on page 287
- Configuration Examples for Enabling Disk Mirroring, on page 292
- Additional References, on page 293

Disk Mirroring Prerequisites

Before enabling disk mirroring, the following conditions must be met:

- 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.
- The secondary storage device specified for the mirroring must be installed in the same node as the primary boot device. The supported storage devices are disk0: and disk1:.
- The secondary storage device must be the same size or larger than the designated primary storage device.
- The secondary storage device must be partitioned.
The primary partition on the secondary storage device must be large enough to contain all data on the primary boot device. This can be an issue if the primary boot device has not yet been partitioned. For example, in the situation where both the primary boot device and the secondary storage device are 1 GB in size, the primary boot device contains 950 MB of data, and the secondary storage device is already partitioned to 800 MB in the primary partition and 200 MB in the secondary partition. In such a case, the 950 MB of data from the primary boot device does not fit on the secondary storage device because of the partition. Such a configuration is rejected and an error is displayed. You need to replace the secondary storage device with a higher capacity device. For information about disk partition sizes, see Related Topics.

Although compactflash: can be used as the secondary device on a Performance Route Processor (PRP–2), there is an issue with the ROM Monitor not being able to boot the minimum boot image (MBI) from the secondary device if the device is not disk0: or disk1:. In such a situation, you would need to go into ROMMON mode and boot the PRP-2 manually using the MBI on the compactflash:.

Related Topics

Information About Disk Mirroring, on page 286

Information About Disk Mirroring

The route switch processor (RSP) card has a primary storage device that is used to store installation packages and configuration files. This primary storage device is referred to as the primary boot device and is essential for booting the RSP and its normal operation.

Disk mirroring replicates the critical data on the primary boot device onto another storage device on the same RSP, henceforth referred to as the secondary device. If the primary boot device fails, applications continue to be serviced transparently by the secondary device, thereby avoiding a switchover to the standby RSP. The failed primary storage device can be replaced or repaired without disruption of service.

Disk mirroring should only mirror critical data on the primary boot device onto a secondary storage device and not any noncritical data such as logging data. To separate critical data from noncritical data, the disk devices need to be partitioned. Disk0: is partitioned to disk0: and disk0a:; disk1: is partitioned to disk1: and disk1a:. Disk0: and disk1: are used for critical data, whereas disk0a: and disk1a: are used for logging data and other noncritical data. Before you can configure disk mirroring on the RSP, you must have partitioned the secondary storage device. The sizes of disk partitions are related to the total disk size, and are provided in Table 36: Size of Disk Partitions in Relation to Size of Disk, on page 286.

Table 36: Size of Disk Partitions in Relation to Size of Disk

<table>
<thead>
<tr>
<th>Size of Disk</th>
<th>Primary Partition Percentage</th>
<th>Secondary Partition Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>less than 900 MB</td>
<td>Partitioning not supported</td>
<td>Partitioning not supported</td>
</tr>
<tr>
<td>900 MB to 1.5 GB</td>
<td>80%</td>
<td>20%</td>
</tr>
<tr>
<td>1.5 GB to 3 GB</td>
<td>60%</td>
<td>40%</td>
</tr>
<tr>
<td>more than 3 GB</td>
<td>50%</td>
<td>50%</td>
</tr>
</tbody>
</table>
How to Enable Disk Mirroring

The tasks in this section describe how to enable and manage disk mirroring.

Enabling Disk Mirroring

Complete the following instructions to enable disk mirroring. After disk mirroring is configured, if there is a fault on the primary boot drive or it cannot be accessed for any reason, control is automatically transferred to the secondary storage device.

**SUMMARY STEPS**

1. `format secondary-device partition [ location node-id ]`
2. Remove any noncritical data from the primary boot device.
3. `configure`
4. `mirror location node-id Primary-device Secondary-device`
5. `commit`
6. `show mirror [ location node-id ]`
7. `mirror verify location node-id`

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td>Partitions the secondary storage device into two partitions.</td>
</tr>
<tr>
<td><code>format secondary-device partition [ location node-id ]</code></td>
<td>• If the device is already partitioned, you do not need to perform this step.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td><code>RP/0/RSP0/CPU0:router# format disk1: partition</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 2</strong></td>
<td>The primary boot device should contain installation packages and configuration files only. Log files can be copied to the “a” partition of the secondary device, for example disk1a: .</td>
</tr>
<tr>
<td></td>
<td>Remove any noncritical data from the primary boot device.</td>
</tr>
<tr>
<td><strong>Step 3</strong></td>
<td>Enables disk mirroring of the primary-device to the secondary-device .</td>
</tr>
<tr>
<td><code>configure</code></td>
<td>If the primary boot device is not partitioned, the following occurs:</td>
</tr>
<tr>
<td><strong>Step 4</strong></td>
<td>• The contents of the primary device are replicated to the secondary device</td>
</tr>
<tr>
<td><code>mirror location node-id Primary-device Secondary-device</code></td>
<td>• Control of the mirroring server switches to the secondary storage device.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>• The primary device is partitioned.</td>
</tr>
<tr>
<td><code>RP/0/RSP0/CPU0:router(config)# mirror location 0/rsp0/cpu0 disk0:disk1:</code></td>
<td>• Data is replicated back to the primary boot device.</td>
</tr>
</tbody>
</table>
Replacing the Secondary Mirroring Device

Follow this procedure if you need to replace the secondary boot device used in the disk mirroring process.

SUMMARY STEPS

1. `show mirror [location node-id]`
2. `mirror pause [location node-id]`
3. `show mirror [location node-id]`
4. `unmount secondary-device [location node-id]`
5. Remove the device and insert a new device.
6. `format secondary-device partition [location node-id]`
7. `show media [location node-id]`
8. `mirror resume [location node-id]`
9. `show mirror [location node-id]`

DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td><strong>Purpose</strong></td>
</tr>
<tr>
<td><code>show mirror [location node-id]</code></td>
<td>Verifies that mirroring is active. In the output, the Current Mirroring State should be redundant.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td><code>RP/0/RSP0/CPU0:router# show mirror</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 2</strong></td>
<td></td>
</tr>
<tr>
<td><code>mirror pause [location node-id]</code></td>
<td>Temporarily pauses disk mirroring.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td><code>RP/0/RSP0/CPU0:router# mirror pause</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong></td>
<td></td>
</tr>
<tr>
<td><code>show mirror [location node-id]</code></td>
<td>Verifies that mirroring has paused. In the output, the Current Mirroring State should be paused.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td><code>RP/0/RSP0/CPU0:router# show mirror</code></td>
<td></td>
</tr>
</tbody>
</table>
**Replacing the Primary Mirroring Device**

In the event that your primary boot disk is defective and you need to replace it while disk mirroring is enabled, perform this task.

**SUMMARY STEPS**

1. `show mirror [location node-id]`
2. `configure`
3. `mirror location node-id Primary-device Secondary-device`
4. `commit`
5. `show mirror [location node-id]`
6. `mirror pause [location node-id]`
7. `show mirror`
8. `unmount secondary-device [location node-id]`
9. Remove the device and insert a new device.
### Configuring Disk Mirroring

#### Replacing the Primary Mirroring Device

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td>show mirror [location node-id]</td>
<td>Verifies that mirroring is in the redundant state. In the output, the <em>Current Mirroring State</em> should be redundant. If mirroring is not in the redundant state, you cannot proceed with the procedure. You must wait until mirroring is in the redundant state.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>RP/0/RSP0/CPU0:router# show mirror</td>
<td></td>
</tr>
<tr>
<td><strong>Step 2</strong></td>
<td>configure</td>
<td>Swaps the device roles such that the primary mirroring device now becomes the secondary device and the secondary mirroring device becomes the primary device.</td>
</tr>
<tr>
<td><strong>Step 3</strong></td>
<td>mirror location node-id Primary-device Secondary-device</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>RP/0/RSP0/CPU0:router(config)# mirror location 0/RSPO/CPU0 disk1:disk0:</td>
<td></td>
</tr>
<tr>
<td><strong>Step 4</strong></td>
<td>commit</td>
<td></td>
</tr>
<tr>
<td><strong>Step 5</strong></td>
<td>show mirror [location node-id]</td>
<td>Verifies that the primary device is now the secondary device and vice versa. In the output, if disk0: was the primary disk that you want to replace, it should now be listed as the secondary device.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>RP/0/RSP0/CPU0:router# show mirror</td>
<td></td>
</tr>
<tr>
<td><strong>Step 6</strong></td>
<td>mirror pause [location node-id]</td>
<td>Temporarily pauses disk mirroring.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>RP/0/RSP0/CPU0:router# mirror pause</td>
<td></td>
</tr>
<tr>
<td><strong>Step 7</strong></td>
<td>show mirror</td>
<td>Verifies that mirroring has paused. In the output, the <em>Current Mirroring State</em> should be paused.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>RP/0/RSP0/CPU0:router# show mirror</td>
<td></td>
</tr>
<tr>
<td><strong>Step 8</strong></td>
<td>unmount secondary-device [location node-id]</td>
<td>Unmounts the secondary device which is the device that you want to replace. Initially, this was the primary device.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>RP/0/RSP0/CPU0:router# unmount disk1:</td>
<td></td>
</tr>
<tr>
<td>Step</td>
<td>Command or Action</td>
<td>Purpose</td>
</tr>
<tr>
<td>--------</td>
<td>----------------------------------------------------------------------------------</td>
<td>----------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>9</td>
<td>Remove the device and insert a new device.</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td><code>show media [location node-id]</code></td>
<td>Verifies that the new disk is partitioned. You should see that the new device is mounted. If the new device is not partitioned, format the device as indicated in the next step.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td><code>RP/0/RSP0/CPU0:router# show media</code></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td><em>(Optional) <code>format secondary-device partition [location node-id]</code></em></td>
<td>Formats the device. You only need to perform this step if the new device is not partitioned.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td><code>RP/0/RSP0/CPU0:router# format disk1: partition</code></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td><code>mirror resume [location node-id]</code></td>
<td>Resumes mirroring.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td><code>RP/0/RSP0/CPU0:router# mirror resume</code></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td><code>show mirror [location node-id]</code></td>
<td>Verifies that mirroring has restarted. In the output, the Current Mirroring State should be Syncing.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td>It can take 15 to 30 minutes for the mirroring process to complete. The exact time depends on the number of packages or files on the boot device. When the mirroring is complete, the Current Mirroring State should be Redundant.</td>
</tr>
<tr>
<td></td>
<td><code>RP/0/RSP0/CPU0:router# show mirror</code></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td><code>configure</code></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td><code>mirror location node-id Primary-device Secondary-device</code></td>
<td>Swaps the device roles back so that the newly inserted device becomes the primary device.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td><code>RP/0/RSP0/CPU0:router(config)# mirror location 0/RSP0 /CPU0 disk0:disk1:</code></td>
<td></td>
</tr>
<tr>
<td>16</td>
<td><code>show mirror [location node-id]</code></td>
<td>Verifies that the new device is now the primary device.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td><code>RP/0/RSP0/CPU0:router# show mirror</code></td>
<td></td>
</tr>
</tbody>
</table>
Configuration Examples for Enabling Disk Mirroring

Enabling Disk Mirroring: Example

In the following example, disk mirroring is enabled on a router:

format disk1: partition

This operation will destroy all data on "disk1:" and partition device. Continue? [confirm] y

Device partition disk1: is now formatted and is available for use.

configure
  mirror location 0/0/cpu0 disk0:disk1:
  commit

show mirror Command Output: Example

RP/0/RSP0/CPU0:router(admin)# show mirror location all

Tue Dec 7 13:02:26.520 PST
Mirror Information for 0/RSP0/CPU0.
---------------------------------------------
Mirroring Enabled
  Configured Primary:       disk0:
  Configured Secondary:    disk1:

Current Mirroring State:       Redundant
Current Physical Primary:     disk0:
Current Physical Secondary:   disk1:

Mirroring Logical Device:       disk0:
Mirroring Logical Device2:     disk1:

Physical Device | State  | Flags
----------------|--------|--------
disk0:          | Available| Enabled
disk1:          | Available| Enabled
compactflash:   | Available|        
(null):         | Available|        
disk0a:         | Available|        
disk1a:         | Available|        
compactflasha:  | Not Present|     
harddisk:       | Available|        

Mirroring Rommon Variable
  BOOT_DEV_SEQ_CONF = disk0:;disk1:
  BOOT_DEV_SEQ_OPER = disk0:;disk1:
  MIRROR_ENABLE = Y
mirror verify Command Output: Example

RP/0/RSP0/CPU0:router# mirror verify

Mirror Verify Information for 0/0/CPU0.
--------------------------------------------------------
  Primary device and secondary device are fully synchronized.

Additional References

The following sections provide references related to disk mirroring configuration.

Related Documents

<table>
<thead>
<tr>
<th>Related Topic</th>
<th>Document Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial system bootup and configuration information for a router using the Cisco IOS XR software</td>
<td>Cisco ASR 9000 Series Aggregation Services Router Getting Started Guide</td>
</tr>
<tr>
<td>Information about user groups and task IDs</td>
<td>Configuring AAA Services on the Cisco ASR 9000 Series Router module of System Security Configuration Guide for Cisco ASR 9000 Series Routers</td>
</tr>
<tr>
<td>Cisco IOS XR command master list</td>
<td>Cisco ASR 9000 Series Aggregation Services Router Commands Master List</td>
</tr>
<tr>
<td>Cisco IOS XR boot commands</td>
<td>Boot Commands on the Cisco ASR 9000 Series Router module of System Management Command Reference for Cisco ASR 9000 Series Routers</td>
</tr>
</tbody>
</table>

Standards

<table>
<thead>
<tr>
<th>Standards</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>No new or modified standards are supported by this feature, and support for existing standards has not been modified by this feature.</td>
<td>—</td>
</tr>
</tbody>
</table>

MIBs

<table>
<thead>
<tr>
<th>MIBs</th>
<th>MIBs Link</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>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: <a href="http://cisco.com/public/sw-center/netmgmt/cmtk/mibs.shtml">http://cisco.com/public/sw-center/netmgmt/cmtk/mibs.shtml</a></td>
</tr>
</tbody>
</table>
### RFCs

<table>
<thead>
<tr>
<th>RFCs</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>No new or modified RFCs are supported by this feature, and support for existing RFCs has not been modified by this feature.</td>
<td>—</td>
</tr>
</tbody>
</table>

### Technical Assistance

<table>
<thead>
<tr>
<th>Description</th>
<th>Link</th>
</tr>
</thead>
<tbody>
<tr>
<td>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.</td>
<td><a href="http://www.cisco.com/cisco/web/support/index.html">http://www.cisco.com/cisco/web/support/index.html</a></td>
</tr>
</tbody>
</table>
CHAPTER 16

Configuring Open Flow Agent

OpenFlow is a specification from the Open Networking Foundation (ONF) that defines a flowbased forwarding infrastructure (L2-L4 Ethernet switch model) and a standardized application programmatic interface (protocol definition) to learn capabilities, add and remove flow control entries and request statistics. OpenFlow allows a controller to direct the forwarding functions of a switch through a secure channel.

This module has details about the Open Flow Agent, relevant concepts and configurations.

Table 37: Feature History for Implementing OFACisco IOS XR Software

<table>
<thead>
<tr>
<th>Release</th>
<th>Modification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Release 5.1.2</td>
<td>This feature was introduced.</td>
</tr>
</tbody>
</table>

- OpenFlow, on page 296
- OpenFlow Agent Packet In and Out Feature, on page 298
- OpenFlow Agent with NetFlow Collection and Analytics, on page 299
- OFA on Cisco Routers and Switches, on page 300
- Functional Components, on page 300
- OFA on ASR 9000 series routers, on page 300
- OFA on OnePK, on page 300
- OpenFlow Matches, on page 301
- OpenFlow Actions, on page 303
- Cisco Extension Actions, on page 305
- Set Field Actions, on page 305
- Configuring OneP for Openflow, on page 308
- Configuring a Layer 2 Logical Switch for the OpenFlow Agent, on page 308
- Configuring a Layer 2_Layer 3 Logical Switch for the OpenFlow Agent, on page 310
- Configuring a Layer 3_VRF Logical Switch for the OpenFlow Agent, on page 311
- Configuring a Layer 3_Dual-stack Logical Switch for the OpenFlow Agent, on page 312
- Enabling TLS, on page 314
- Configuring NetFlow for the OpenFlow Agent, on page 314
- Configuration Examples: Openflow, on page 317
- Usecase for Layer2, on page 319
- Usecase for Layer3, on page 319
OpenFlow

OpenFlow is an open standard to communicate between controllers, which are running applications and network elements (such as, routers and switches). The OpenFlow agent runs on RSP and connects to an external OpenFlow controller and converts OpenFlow messages to corresponding OnePK APIs.

For details regarding OpenFlow, please refer the OpenFlow chapter in the *System Management Configuration Guide for Cisco ASR 9000 Series Routers*.

An overview of OFA

OpenFlow is a specification from the Open Networking Foundation (ONF) that defines a flow based forwarding infrastructure (L2-L4 Ethernet switch model) and a standardized application programmatic interface (protocol definition) to learn capabilities, add and remove flow control entries and request statistics. OpenFlow allows a controller to direct the forwarding functions of a switch through a secure channel. Local device configuration is out of scope of the OpenFlow protocol. OpenFlow essentially provides a forwarding instruction set, allowing applications to directly program any-to-any routing and switching, with header field rewrite. New matches and actions can be applied to packets in arbitrary unconstrained fashion, allowing routing and switching on the new criteria. Routers and switches embed the fast packet forwarding and the high level routing decisions together into their software on the same device. With only a few exceptions based on user configuration, all routing and switching decisions are made by the built-in protocols and control plane logic that reside on the switch.

Prerequisites for OpenFlow Agent

The following prerequisites are required to use the OpenFlow agent on the platforms supporting IOS-XR:

- Special build of the Release 5.1.x software that has the OpenFlow functionality is required.
- The Enhanced Ethernet line card for the Cisco ASR 9000 Series Router is required for the OpenFlow agent feature.
- Any controller with version 1.1 or 1.3 is required (example, POX, ODL).
- The asr9k-k9sec Package Installation Envelope (PIE) must be present. The asr9k-mpls PIE is required for support on MPLS core (such as, PWHE).

Restrictions for OpenFlow Agent

- Same interface cannot be added to more than one logical open flow switch.
- No support for output as an action for layer3 openflow logical switch (such as pipeline131, 132).
- Only layer 3 interface support for netflow sampling statistics.

Advantages

The advantages with Open Flow Agent are:

- increases network scalability
- reduces network complexity
• allows greater application control
• enables customer-feature-independence

About OpenFlow

The OpenFlow protocol is based on the concept of an Ethernet switch, with an internal flow-table and standardized interface to allow traffic flows on a switch to be added or removed. The OpenFlow protocol defines the communications channel between the OpenFlow agent and the OpenFlow controller. In an OpenFlow network, the OpenFlow Agent exists on the switch and the OpenFlow controller exists on a server, which is external to the switch. Any network management is either part of the controller or accomplished through the controller.

In the Cisco OpenFlow scheme, the physical switch is divided into multiple logical switches by using the CLI to configure the connection to the controller for each logical switch and enable interfaces for each logical switch. The Openflow Agent software manages these logical switches.

The following figure shows the Cisco implementation of the OpenFlow network.

OpenFlow Mode for ASR9000

Openflow for the Cisco ASR 9000 Series router functions in the Integrated Hybrid mode. In this mode, both Openflow and normal switching and routing (for layer 3) operations such as L2 ethernet switching, L3 routing, etc are supported. Packets processed as the Openflow forwarding path can be processed as a normal forwarding path.

OpenFlow Table Types

An OpenFlow flow table consists of a set of flows. Each flow contains a set of matches and actions. A table has a set of capabilities in terms of supported matches and actions. Just like a policy-map, a table can be applied to a set of targets but only in the ingress direction. Hence, OpenFlow matches and actions are applied to the incoming traffic only.

Note

A set of ordered tables is referred to as a pipeline. A pipeline may contain one or more ordered tables. An OpenFlow pipeline of an OpenFlow switch on ASR9K supports only one flow table.
### Table 38: OpenFlow Table Types

<table>
<thead>
<tr>
<th>Table Type</th>
<th>Pipeline</th>
<th>Supported Interfaces</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>L2</td>
<td>129</td>
<td>Bridge-domain, Gigabit ethernet, Bundle, Bundle-subinterfaces, PWHE-subinterfaces</td>
<td>• Supports L2 header matches.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Supports L2 actions.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Can be applied to the ingress L2 interfaces.</td>
</tr>
<tr>
<td>L2_L3</td>
<td>130</td>
<td>Bridge-domain, Gigabit ethernet, Bundle, Bundle-subinterfaces, PWHE-subinterfaces</td>
<td>• Supports L2 and L3 (IPv4/IPv6) header matches.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Supports L2 actions.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Can be applied to the ingress L2 interfaces.</td>
</tr>
<tr>
<td>L3_V4</td>
<td>131</td>
<td>VRF and global interfaces, BVI (ipv4 only), Bridge-domain, Gigabit ethernet, Bundle, Bundle-subinterfaces</td>
<td>• Supports L3 (IPv4) header matches.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Supports L3 (IPv4) actions.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Can be applied to the ingress L3 interfaces.</td>
</tr>
<tr>
<td>L3_DS</td>
<td>132</td>
<td>VRF and global interfaces, BVI, Bridge-domain, Gigabit ethernet, Bundle, Bundle-subinterfaces</td>
<td>• Supports L2 and L3 (IPv4/IPv6) header matches.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Supports L3 (IPv4/IPv6) actions.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Can be applied to the ingress L3 interfaces.</td>
</tr>
</tbody>
</table>

- **L2 Table**--Supports L2 header matches and has L2 actions only. This table type can be applied to the ingress of an L2 interface.
- **L2_L3 Table**--Supports L2 and L3 header matches and has L2 actions only. Match parameters can be IPv4 or IPv6 type. This table type can be applied to the ingress of an L2 interface.
- **L3_V4 Table**--Supports L3 IPv4 header matches and has L3 actions only. This table type can be applied to the ingress of L3 interfaces.
- **L3_DS(Dual Stack) Table**--Supports L2 and L3 IPv4 and IPv6 (Dual Stack) matches and has L3 actions only. This table type can be applied to the ingress of L3 interfaces.

### OpenFlow Agent Packet In and Out Feature

The Packet In and Out feature allows a flow to be programmed by the OpenFlow Agent logical switch so that packets are sent to the Controller. The special output port: **OFP_CONTROLLER** is specified for the flow action.

The Packet In and Out feature enables support for the OpenFlow output-to-port action. The output action tells the OpenFlow Agent to send all packets matching the flow to a specific port.
OpenFlow Agent with NetFlow Collection and Analytics

Applications can be provided with on-demand analytics by using the OpenFlow protocol with NetFlow. NetFlow provides statistics on packets flowing through the router, and is the standard for acquiring IP operational data from IP networks.

The following NetFlow maps must be configured:

- Flow Exporter Map—Specifies the destination IP address of the NetFlow collector where the NetFlow Version 9 packets are sent.
- Flow Monitor Map—Specifies the profile of the NetFlow producer, including the timeout values of active and inactive timers, size of the NetFlow cache and the exporter to be used.
- Sampler Map—Specifies how often Network Processor (NPU) needs to sample incoming and outgoing packets and create flow-packets to punt to the Line Card (LC) Central Processing Unit (CPU).

The following parameters must be specified on the OpenFlow Agent logical switch:

- Interface associated with the OpenFlow Agent logical switch that is enabled for NetFlow.
- Flow Monitor Map
- Sampler Map
- Controller IP address

Figure 9: OpenFlow Agent and NetFlow collection and analytics workflow

1. The help desk application tells the analytics application that Customer 1 has a problem.
2. The analytics application determines that it requires more information and requests more network data about Customer 1 from the Controller.
3. The Controller instructs the OpenFlow logical switch on the router to look for Customer 1 packets and generate and export NetFlow data based on Customer 1 packet flows.
4. The OpenFlow Agent logical switch exports NetFlow packets to the analytics application where they are processed.

5. The analytics application informs the help desk application of the problem.

**OFA on Cisco Routers and Switches**

OpenFlow SDN Applications expect network elements to speak standard OpenFlow protocol and to implement standard OpenFlow switch model. The OpenFlow Agent as a local process provides:

- OF protocol stack
- OF switch model derived from disparate Cisco software and hardware
- Version, model and feature negotiation
- Local aggregation of state and statistics
- Native dedicated CLI and troubleshooting
- High Availability

**Functional Components**

OpenFlow supports the configuration of multiple controllers for a logical switch. The Openflow agent can connect to a single controller or up to 8 controllers. It creates connections to all configured controllers to provide the controllers access to the OpenFlow logical switch flow tables and interfaces. It will receive flow entries from the controllers and report interface and flow status and statistics to the controllers.

The set nexthop action for layer 3 matches is implemented through a Cisco extension to the OpenFlow (1.0 and 1.3) protocol.

**OFA on ASR 9000 series routers**

The OpenFlow Agent supports multiple logical switch instances on ASR9K platform, with each logical switch managing a set of physical/logical interfaces, an L2 bridge domain or a VRF. Each logical switch may have one openflow connection to a single controller, or multiple connects for reliability, each to a different controller. The openflow connection to the controller uses standard TLS or plain TCP.

When the logical switch initialises a connection to the configured controller, the signaling version for the agent-controller connection is negotiated based on the bitmap version supported on both- agent and controller sides. When a logical switch starts up for the first time or at the time a logical switch loses contact with all controllers, it operates in either fail-secure mode (with default-set rule) or fail-standalone mode depending on the CLI of fail-standalone (on or off). The default for configuration is in the fail-secure mode.

**OFA on OnePK**

OnePK and OpenFlow have overlapping goals. The OpenFlow protocol features and switch model have similarities with the Policy and DataPath Service Sets. Building the OpenFlow Agent with onePK increases portability of the OpenFlow Agent. OpenFlow Agent is designed on the top of onePK presentation layer and it depends on following onePK Service Sets:
- Element SS Presentation Layer for interface configurations, statistics and state
- Policy SS Presentation Layer for match-action flow processing and flow stats, as well as hardware capabilities
- DataPath SS Presentation Layer for packet capture and inject
- Routing Service Set for VRF support

### OpenFlow Matches

Matches are supported on ingress port and various packet headers depending upon the packet type. Flows can have priorities. Hence, the highest priority flow entry that matches the packet gets selected.

Following table shows the list of matches supported on ASR9K for various table types:

<table>
<thead>
<tr>
<th>OpenFlow Matches</th>
<th>OpenFlow Switch Types Supported on ASR9K</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Applied to L2 Bridge domain</td>
</tr>
<tr>
<td>OXM Flow match field type for OpenFlow basic class</td>
<td>L2 only</td>
</tr>
<tr>
<td>OFPXMT_OFB_IN_PORT</td>
<td>Switch input port</td>
</tr>
<tr>
<td>OFPXMT_OFB_IN_PHY_PORT</td>
<td>Switch physical port</td>
</tr>
<tr>
<td>OFPXMT_OFB_METADATA</td>
<td>Metadata passed between tables</td>
</tr>
<tr>
<td>OFPXMT_OFB_ETH_DST</td>
<td>Ethernet destination address</td>
</tr>
<tr>
<td>OFPXMT_OFB_ETH_SRC</td>
<td>Ethernet source address</td>
</tr>
<tr>
<td>OFPXMT_OFB_ETH_TYPE</td>
<td>Ethernet frame type</td>
</tr>
<tr>
<td>OFPXMT_OFB_VLAN_VID</td>
<td>VLAN ID</td>
</tr>
<tr>
<td>OFPXMT_OFB_VLAN_PCP</td>
<td>VLAN priority</td>
</tr>
<tr>
<td>OFPXMT_OFB_IP_DSCP</td>
<td>IP DSCP (6 bits in ToS field)</td>
</tr>
<tr>
<td>OFPXMT_OFB_IP_ECN</td>
<td>IP ECN (2 bits in ToS field)</td>
</tr>
<tr>
<td>OFPXMT_OFB_IP_PROTO</td>
<td>IP protocol</td>
</tr>
<tr>
<td>OpenFlow Matches</td>
<td>OpenFlow Switch Types Supported on ASR9K</td>
</tr>
<tr>
<td>------------------</td>
<td>------------------------------------------</td>
</tr>
<tr>
<td></td>
<td>Applied to L2 Bridge domain</td>
</tr>
<tr>
<td>OFPXMT_OFB_IPV4_SRC</td>
<td>IPv4 source address</td>
</tr>
<tr>
<td>OFPXMT_OFB_IPV4_DST</td>
<td>IPv4 destination address</td>
</tr>
<tr>
<td>OFPXMT_OFB_TCP_SRC</td>
<td>TCP source port</td>
</tr>
<tr>
<td>OFPXMT_OFB_TCP_DST</td>
<td>TCP destination port</td>
</tr>
<tr>
<td>OFPXMT_OFB_UDP_SRC</td>
<td>UDP source port</td>
</tr>
<tr>
<td>OFPXMT_OFB_UDP_DST</td>
<td>UDP destination port</td>
</tr>
<tr>
<td>OFPXMT_OFB_SCTP_SRC</td>
<td>SCTP source port</td>
</tr>
<tr>
<td>OFPXMT_OFB_SCTP_DST</td>
<td>SCTP destination port</td>
</tr>
<tr>
<td>OFPXMT_OFB_ICMPV4_TYPE</td>
<td>ICMP type</td>
</tr>
<tr>
<td>OFPXMT_OFB_ICMPV4_CODE</td>
<td>ICMP code</td>
</tr>
<tr>
<td>OFPXMT_OFB_ARP_OP</td>
<td>ARP opcode</td>
</tr>
<tr>
<td>OFPXMT_OFB_ARP_SPA</td>
<td>ARP source IPv4 address</td>
</tr>
<tr>
<td>OFPXMT_OFB_ARP_TPA</td>
<td>ARP target IPv4 address</td>
</tr>
<tr>
<td>OFPXMT_OFB_ARP_SHA</td>
<td>ARP source hardware address</td>
</tr>
<tr>
<td>OFPXMT_OFB_ARP_THA</td>
<td>ARP target hardware address</td>
</tr>
<tr>
<td>OFPXMT_OFB_IPV6_SRC</td>
<td>IPv6 source address</td>
</tr>
<tr>
<td>OFPXMT_OFB_IPV6_DST</td>
<td>IPv6 destination address</td>
</tr>
</tbody>
</table>
### OpenFlow Matches

<table>
<thead>
<tr>
<th>OpenFlow Matches</th>
<th>OpenFlow Switch Types Supported on ASR9K</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Applied to L2 Bridge domain</td>
</tr>
<tr>
<td>OFPXMT_OFB_IPV6_FLABEL</td>
<td>IPv6 Flow Label</td>
</tr>
<tr>
<td>OFPXMT_OFB_ICMPV6_TYPE</td>
<td>ICMPv6 type</td>
</tr>
<tr>
<td>OFPXMT_OFB_ICMPV6_CODE</td>
<td>ICMPv6 code</td>
</tr>
<tr>
<td>OFPXMT_OFB_IPV6_ND_TARGET</td>
<td>Target address for ND</td>
</tr>
<tr>
<td>OFPXMT_OFB_IPV6_ND_SLL</td>
<td>Source link-layer for ND</td>
</tr>
<tr>
<td>OFPXMT_OFB_IPV6_ND_TLL</td>
<td>Target link-layer for ND</td>
</tr>
<tr>
<td>OFPXMT_OFB_MPLS_LABEL</td>
<td>MPLS label</td>
</tr>
<tr>
<td>OFPXMT_OFB_MPLS_TC</td>
<td>MPLS TC</td>
</tr>
<tr>
<td>OFPXMT_OFP_MPLS_BOS</td>
<td>MPLS BoS bit</td>
</tr>
<tr>
<td>OFPXMT_OFB_PBB_ISID</td>
<td>PBB I-SID</td>
</tr>
<tr>
<td>OFPXMT_OFB_TUNNEL_ID</td>
<td>Logical Port Metadata</td>
</tr>
<tr>
<td>OFPXMT_OFB_IPV6_EXTHDR</td>
<td>IPv6 Extension Header pseudo-field</td>
</tr>
</tbody>
</table>

### OpenFlow Actions

Packet forwarding and packet modification types of actions are supported. The lists of actions are always immediately applied to the packet.

- Only “Apply-actions” instruction (OFPIT_APPLY_ACTIONS) of OpenFlow 1.3 is supported.
- Pipeline processing instructions that allow packets to be sent to subsequent tables for further processing are not supported in this release.
- Group tables and Meter tables are not supported.

Following table shows the list of action types supported on ASR9K for various table types.
## OpenFlow Actions

<table>
<thead>
<tr>
<th>OXM Flow action field type for OpenFlow basic class</th>
<th>Description</th>
<th>Applied to L2 Bridge domain</th>
<th>Applied to L3 or L3 VRF interface</th>
</tr>
</thead>
<tbody>
<tr>
<td>OFPAT_OUTPUT</td>
<td>Output to switch port.</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>OFPAT_COPY_TTL_OUT</td>
<td>Copy TTL &quot;outwards&quot;</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>OFPAT_COPY_TTL_IN</td>
<td>Copy TTL &quot;inwards&quot;</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>OFPAT_SET_MPLS_TTL</td>
<td>MPLS TTL</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>OFPAT_DEC_MPLS_TTL</td>
<td>Decrement MPLS TTL</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>OFPAT_PUSH_VLAN</td>
<td>Push a new VLAN tag</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>OFPAT_POP_VLAN</td>
<td>Pop the outer VLAN tag</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>OFPAT_PUSH_MPLS</td>
<td>Push a new MPLS tag</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>OFPAT_POP_MPLS</td>
<td>Pop the outer MPLS tag</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>OFPAT_SET_QUEUE</td>
<td>Set queue id when outputting to a port</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>OFPAT_GROUP</td>
<td>Apply group</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>OFPAT_SET_NW_TTL</td>
<td>IP TTL</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>OFPAT_DEC_NW_TTL</td>
<td>Decrement IP TTL</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>OFPAT_SET_FIELD</td>
<td>Set a header field using OXM TLV format</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>OFPAT_PUSH_PBB</td>
<td>Push a new PBB service tag (I-TAG)</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>OFPAT_POP_PBB</td>
<td>Pop the outer PBB service tag</td>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>
Cisco Extension Actions

The set ipv4 or set ipv6 nexthop actions are used to redirect an ipv4 or ipv6 packet to the specified nexthop address, instead of using the destination address in the packet. This provides ABF (ACL Based Forwarding) kind of functionality using OpenFlow. However, VRF support and nexthop tracking as supported by CLI based ABF feature is not supported in this release.

The set fcid (Forward Class ID) action can be used to support PBTS (Policy Based Tunnel Selection) functionality using OpenFlow.

Following table shows the list of actions added by Cisco to support some extra features on ASR9K.

<table>
<thead>
<tr>
<th>Cisco proprietary actions</th>
<th>OpenFlow Switch Types Supported on ASR9K</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Applied to L2 Bridge domain</td>
</tr>
<tr>
<td>OXM Flow match field type for OpenFlow basic class</td>
<td>Description</td>
</tr>
<tr>
<td>Set Ipv4 Nexthop</td>
<td>Set ipv4 nexthop address</td>
</tr>
<tr>
<td>Set Ipv6 Nexthop</td>
<td>Set ipv6 nexthop address</td>
</tr>
<tr>
<td>Set Forward Class ID</td>
<td>Set forward class ID</td>
</tr>
<tr>
<td>Set VRF</td>
<td>Set forward ipv4/ipv6 packet based on VRF</td>
</tr>
</tbody>
</table>

Set Field Actions

This table lists the set field actions supported by the Cisco ASR 9000 series router:

<table>
<thead>
<tr>
<th>OpenFlow Matches</th>
<th>OpenFlow Switch Types Supported on ASR9K</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Applied to L2 Bridge domain</td>
</tr>
<tr>
<td>OXM Flow match field type for OpenFlow basic class</td>
<td>Description</td>
</tr>
<tr>
<td>OFPXMT_OFB_ETH_DST</td>
<td>Ethernet destination address</td>
</tr>
<tr>
<td>OFPXMT_OFB_ETH_SRC</td>
<td>Ethernet source address</td>
</tr>
<tr>
<td>OpenFlow Matches</td>
<td>OpenFlow Switch Types Supported on ASR9K</td>
</tr>
<tr>
<td>------------------</td>
<td>------------------------------------------</td>
</tr>
<tr>
<td>OFPXMT_OFB_ETH_TYPE</td>
<td>Ethernet frame type</td>
</tr>
<tr>
<td>OFPXMT_OFB_VLAN_VID</td>
<td>VLAN ID</td>
</tr>
<tr>
<td>OFPXMT_OFB_VLAN_PCP</td>
<td>VLAN priority</td>
</tr>
<tr>
<td>OFPXMT_OFB_IP_DSCP</td>
<td>IP DSCP (6 bits in ToS field)</td>
</tr>
<tr>
<td>OFPXMT_OFB_IP_ECN</td>
<td>IP ECN (2 bits in ToS field)</td>
</tr>
<tr>
<td>OFPXMT_OFB_IP_PROTO</td>
<td>IP protocol</td>
</tr>
<tr>
<td>OFPXMT_OFB_IPV4_SRC</td>
<td>IPv4 source address</td>
</tr>
<tr>
<td>OFPXMT_OFB_IPV4_DST</td>
<td>IPv4 destination address</td>
</tr>
<tr>
<td>OFPXMT_OFB_TCP_SRC</td>
<td>TCP source port</td>
</tr>
<tr>
<td>OFPXMT_OFB_TCP_DST</td>
<td>TCP destination port</td>
</tr>
<tr>
<td>OFPXMT_OFB_UDP_SRC</td>
<td>UDP source port</td>
</tr>
<tr>
<td>OFPXMT_OFB_UDP_DST</td>
<td>UDP destination port</td>
</tr>
<tr>
<td>OFPXMT_OFB_SCTP_SRC</td>
<td>SCTP source port</td>
</tr>
<tr>
<td>OFPXMT_OFB_SCTP_DST</td>
<td>SCTP destination port</td>
</tr>
<tr>
<td>OFPXMT_OFB_ICMPV4_TYPE</td>
<td>ICMP type</td>
</tr>
<tr>
<td>OFPXMT_OFB_ICMPV4_CODE</td>
<td>ICMP code</td>
</tr>
<tr>
<td>OFPXMT_OFB_ARP_OP</td>
<td>ARP opcode</td>
</tr>
<tr>
<td>OFPXMT_OFB_ARP_SPA</td>
<td>ARP source IPv4 address</td>
</tr>
<tr>
<td>OpenFlow Matches</td>
<td>OpenFlow Switch Types Supported on ASR9K</td>
</tr>
<tr>
<td>----------------------------------</td>
<td>-----------------------------------------</td>
</tr>
<tr>
<td></td>
<td>Applied to L2 Bridge domain</td>
</tr>
<tr>
<td>OFPXMT_OFB_ARP_TPA</td>
<td>ARP target IPv4 address</td>
</tr>
<tr>
<td>OFPXMT_OFB_ARP_SHA</td>
<td>ARP source hardware address</td>
</tr>
<tr>
<td>OFPXMT_OFB_ARP_THA</td>
<td>ARP target hardware address</td>
</tr>
<tr>
<td>OFPXMT_OFB_IPV6_SRC</td>
<td>IPv6 source address</td>
</tr>
<tr>
<td>OFPXMT_OFB_IPV6_DST</td>
<td>IPv6 destination address</td>
</tr>
<tr>
<td>OFPXMT_OFB_IPV6_FLABEL</td>
<td>IPv6 Flow Label</td>
</tr>
<tr>
<td>OFPXMT_OFB_ICMPV6_TYPE</td>
<td>ICMPv6 type</td>
</tr>
<tr>
<td>OFPXMT_OFB_ICMPV6_CODE</td>
<td>ICMPv6 code</td>
</tr>
<tr>
<td>OFPXMT_OFB_IPV6_ND_TARGET</td>
<td>Target address for ND</td>
</tr>
<tr>
<td>OFPXMT_OFB_IPV6_ND_SLL</td>
<td>Source link-layer for ND</td>
</tr>
<tr>
<td>OFPXMT_OFB_IPV6_ND_TLL</td>
<td>Target link-layer for ND</td>
</tr>
<tr>
<td>OFPXMT_OFB_MPLS_LABEL</td>
<td>MPLS label</td>
</tr>
<tr>
<td>OFPXMT_OFB_MPLS_TC</td>
<td>MPLS TC</td>
</tr>
<tr>
<td>OFPXMT_OFB_MPLS_BOS</td>
<td>MPLS BoS bit</td>
</tr>
<tr>
<td>OFPXMT_OFB_PBB_ISID</td>
<td>PBB I-SID</td>
</tr>
<tr>
<td>OFPXMT_OFB_TUNNEL_ID</td>
<td>Logical Port Metadata</td>
</tr>
<tr>
<td>OFPXMT_OFB_IPV6_EXTHDR</td>
<td>IPv6 Extension Header pseudo-field</td>
</tr>
</tbody>
</table>
### Configuring OneP for Openflow

**SUMMARY STEPS**

1. configure
2. onep
3. datapath transport vpathudp sender-id *number*
4. commit

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1 configure</td>
<td></td>
</tr>
<tr>
<td>Step 2 onep</td>
<td>Enters the OneP configuration mode.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>RP/0/RSP0/CPU0:router (config) # onep</td>
</tr>
<tr>
<td>Step 3 datapath transport vpathudp sender-id <em>number</em></td>
<td>Configures the virtual-path udp transport datapath for the specified sender-id.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>RP/0/RSP0/CPU0:router (config) # datapath transport vpathudp sender-id 1</td>
</tr>
<tr>
<td>Step 4 commit</td>
<td></td>
</tr>
</tbody>
</table>

### Configuring a Layer 2 Logical Switch for the OpenFlow Agent

**SUMMARY STEPS**

1. configure
2. openflow
3. switch *switch-id* pipeline *pipeline-number*
4. tls trust-point local *local-tp-name* remote *remote-tp-name*
5. bridge-group SDN-id bridge-domain *switch-id*
6. controller ipv4 *ip-address* security [tls | none]
7. commit
8. commit

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1 configure</td>
<td></td>
</tr>
<tr>
<td>Step</td>
<td>Command or Action</td>
</tr>
<tr>
<td>------</td>
<td>-------------------</td>
</tr>
<tr>
<td>Step 2</td>
<td>openflow</td>
</tr>
<tr>
<td>Example:</td>
<td>RP/0/RSP0/CPU0:router(config)# openflow</td>
</tr>
<tr>
<td>Step 3</td>
<td>switch switch-id pipeline pipeline-number</td>
</tr>
<tr>
<td>Example:</td>
<td>RP/0/RSP0/CPU0:router(config-openflow)# switch 1 pipeline 129</td>
</tr>
<tr>
<td>Step 4</td>
<td>tls trust-point local local-tp-name remote remote-tp-name</td>
</tr>
<tr>
<td>Example:</td>
<td>RP/0/RSP0/CPU0:router(config-openflow-switch)# tls trust-point local tp1 remote tp2</td>
</tr>
<tr>
<td>Step 5</td>
<td>bridge-group SDN-id bridge-domain switch-id</td>
</tr>
<tr>
<td>Example:</td>
<td>RP/0/RSP0/CPU0:router(config-openflow)# bridge-group SDN-1 bridge-domain of2</td>
</tr>
<tr>
<td>Step 6</td>
<td>controller ipv4 ip-address security [tls</td>
</tr>
<tr>
<td>Example:</td>
<td>RP/0/RSP0/CPU0:router(config-openflow-switch)# controller ipv4 5.0.1.1 port 6633 security tls</td>
</tr>
<tr>
<td>Note</td>
<td>The OpenFlow Agent can connect to a single Controller or up to 8 Controllers. Repeat this step if you need to configure additional Controllers. An openflow switch can communicate to multiple controllers (the support for high-availability is a controller functionality).</td>
</tr>
<tr>
<td>Step 7</td>
<td>commit</td>
</tr>
<tr>
<td>Example:</td>
<td>RP/0/RSP0/CPU0:router(logical-switch)# commit</td>
</tr>
<tr>
<td>Step 8</td>
<td>commit</td>
</tr>
</tbody>
</table>

**What to do next**

Repeat these steps to configure another logical switch for the OpenFlow Agent.
Configuring a Layer 2_Layer 3 Logical Switch for the OpenFlow Agent

SUMMARY STEPS

1. **configure**
2. **openflow**
3. **switch switch-id pipeline pipeline-number**
4. **tls trust-point local local-tp-name remote remote-tp-name**
5. **bridge-group SDN-id bridge-domain switch-id**
6. **controller ipv4 ip-address security [tls | none]**
7. **commit**
8. **commit**

DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td>configure</td>
</tr>
<tr>
<td><strong>Step 2</strong></td>
<td>openflow</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>RP/0/RSP0/CPU0:router(config)# openflow</td>
</tr>
<tr>
<td><strong>Step 3</strong></td>
<td>switch switch-id pipeline pipeline-number</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>RP/0/RSP0/CPU0:router(config-openflow)# switch 1 pipeline 130</td>
</tr>
<tr>
<td><strong>Step 4</strong></td>
<td>tls trust-point local local-tp-name remote remote-tp-name</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>RP/0/RSP0/CPU0:router(config-openflow-switch)# tls trust-point local tp1 remote tp2</td>
</tr>
<tr>
<td><strong>Step 5</strong></td>
<td>bridge-group SDN-id bridge-domain switch-id</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>RP/0/RSP0/CPU0:router (config-openflow) # bridge-group SDN-1 bridge-domain of2</td>
</tr>
<tr>
<td><strong>Step 6</strong></td>
<td>controller ipv4 ip-address security [tls</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>RP/0/RSP0/CPU0:router(config-openflow-switch)# controller ipv4 5.0.1.1 port 6633 security tls</td>
</tr>
</tbody>
</table>

Once the controller command is entered, a connection to the OpenFlow controller is started for the logical switch. The tls keyword enables the TLS connection, whereas the none keyword enables the TCP connection.
### Purpose

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>The OpenFlow Agent can connect to a single Controller or up to 8 Controllers. Repeat this step if you need to configure additional Controllers. An openflow switch can communicate to multiple controllers (the support for high-availability is a controller functionality).</td>
</tr>
<tr>
<td><strong>Note</strong></td>
<td></td>
</tr>
</tbody>
</table>

### Step 7

**commit**

*Example:*

```
RP/0/RSP0/CPU0:router(logical-switch)# commit
```

**What to do next**

Repeat these steps to configure another logical switch for the OpenFlow Agent.

### Configuring a Layer 3_VRF Logical Switch for the OpenFlow Agent

#### SUMMARY STEPS

1. `configure`
2. `openflow`
3. `switch switch-id pipeline pipeline-number`
4. `vrf IPv4`
5. `tls trust-point local local-tp-name remote remote-tp-name`
6. `controller ipv4 ip-address security [tls | none]`
7. `commit`
8. `commit`

#### DETAILED STEPS

<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><code>configure</code></td>
<td></td>
</tr>
<tr>
<td></td>
<td><code>openflow</code></td>
<td>Enters the openflow configuration mode.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td><code>RP/0/RSP0/CPU0:router(config)# openflow</code></td>
<td></td>
</tr>
<tr>
<td></td>
<td><code>switch switch-id pipeline pipeline-number</code></td>
<td>Enters the logical switch configuration mode. For L3_V4(VRF) switch, the pipeline number is 131.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td><code>RP/0/RSP0/CPU0:router(config-openflow)# switch 1 pipeline 131</code></td>
<td></td>
</tr>
</tbody>
</table>
### Configuring a Layer 3_Dual-stack Logical Switch for the OpenFlow Agent

**SUMMARY STEPS**

1. `configure`
2. `openflow`
3. `switch switch-id pipeline pipeline-number`
4. `interface type interface-path-id`
5. `tls trust-point local local-tp-name remote remote-tp-name`
6. `bridge-group SDN-id bridge-domain switch-id`
7. `controller ipv4 ip-address security [tls | none]`
8. `commit`
9. `commit`

---

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 4</strong> vrf IPv4</td>
<td>VRF configuration. All the interfaces belonging to IPv4 VRF will be learnt by the openflow switch.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>RP/0/RSP0/CPU0:router(config)# vrf IPv4</td>
<td></td>
</tr>
<tr>
<td><strong>Step 5</strong> tls trust-point local local-tp-name remote remote-tp-name</td>
<td>Enters the TLS configuration mode. Configures the local and remote trustpoints.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>RP/0/RSP0/CPU0:router(config-openflow-switch)# tls trust-point local tp1 remote tp2</td>
<td></td>
</tr>
<tr>
<td><strong>Step 6</strong> controller ipv4 ip-address security [tls</td>
<td>none]</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>RP/0/RSP0/CPU0:router(config-openflow-switch)# controller ipv4 5.0.1.1 port 6633 security tls</td>
<td></td>
</tr>
<tr>
<td><strong>Step 7</strong> commit</td>
<td>Adds the Layer 2 logical switch configuration for the OpenFlow agent to the running configuration.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>RP/0/RSP0/CPU0:router(logical-switch)# commit</td>
<td></td>
</tr>
<tr>
<td><strong>Step 8</strong> commit</td>
<td></td>
</tr>
</tbody>
</table>

### What to do next
Repeat these steps to configure another logical switch for the OpenFlow Agent.
<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>configure</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>openflow</td>
<td>Enters the openflow configuration mode.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>RP/0/RSP0/CPU0:router(config)# openflow</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>switch switch-id pipeline pipeline-number</td>
<td>Enters the logical switch configuration mode. For L3_DS switch, the pipeline number is 132.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>RP/0/RSP0/CPU0:router(config-openflow)# switch 1 pipeline 132</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>interface type interface-path-id</td>
<td>Interface configuration.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>RP/0/RSP0/CPU0:router(config-openflow)# interface Bundle-Ether2.1</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>tls trust-point-local local-tp-name remote remote-tp-name</td>
<td>Enters the TLS configuration mode. Configures the local and remote trustpoints.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>RP/0/RSP0/CPU0:router(config-openflow-switch)# tls trust-point-local tp1 remote tp2</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>bridge-group SDN-id bridge-domain switch-id</td>
<td>Configures the Openflow controller for the logical switch.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>RP/0/RSP0/CPU0:router (config-openflow) # bridge-group SDN-1 bridge-domain of2</td>
<td>Configures the Openflow controller for the logical switch.</td>
</tr>
<tr>
<td>7</td>
<td>controller ipv4 ip-address security [tls</td>
<td>Configures the Openflow controller for the logical switch.</td>
</tr>
<tr>
<td></td>
<td>none]</td>
<td>Once the controller command is entered, a connection to the OpenFlow controller is started for the logical switch.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>RP/0/RSP0/CPU0:router(config-openflow-switch)# controller ipv4 5.0.1.1 port 6633 security tls</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>commit</td>
<td>Adds the Layer 2 logical switch configuration for the OpenFlow agent to the running configuration.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>RP/0/RSP0/CPU0:router(logical-switch)# commit</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>commit</td>
<td></td>
</tr>
</tbody>
</table>

**What to do next**

Repeat these steps to configure another logical switch for the OpenFlow Agent.
Enabling TLS

SUMMARY STEPS

1. configure
2. openflow switch logical-switch-id
3. tls trust-point local local-tp-name remote remote-tp-name
4. commit
5. end

DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1 configure</td>
<td></td>
</tr>
<tr>
<td>Step 2 openflow switch logical-switch-id</td>
<td>Enters the OpenFlow logical switch configuration mode.</td>
</tr>
<tr>
<td>Example: RP/0/RSP0/CPU0:router(config)# openflow switch 100</td>
<td></td>
</tr>
<tr>
<td>Step 3 tls trust-point local local-tp-name remote remote-tp-name</td>
<td>Enters the TLS configuration mode. Configures the local and remote trustpoints.</td>
</tr>
<tr>
<td>Example: RP/0/RSP0/CPU0:router(config-openflow-switch)# tls trust-point local tpl remote tp2</td>
<td></td>
</tr>
<tr>
<td>Step 4 commit</td>
<td>Adds the logical switch configuration for the OpenFlow agent to the running configuration.</td>
</tr>
<tr>
<td>Example: RP/0/RSP0/CPU0:router(config-openflow-switch)# commit</td>
<td></td>
</tr>
<tr>
<td>Step 5 end</td>
<td>Exits logical switch configuration mode and enters EXEC mode.</td>
</tr>
<tr>
<td>Example: RP/0/RSP0/CPU0:router(config-openflow-switch)# end</td>
<td></td>
</tr>
</tbody>
</table>

Configuring NetFlow for the OpenFlow Agent

SUMMARY STEPS

1. configure
2. flow exporter-map fem-name
3. destination location
4. version v9
5. commit
6. exit
7. flow monitor-map map-name
8. record ipv4
9. exporter map-name
10. cache entries number
11. cache timeout {active timeout-value | inactive timeout-value | update timeout-value}
12. commit
13. exit
14. sampler-map map-name
15. random 1 out-of sampling-interval
16. commit
17. exit
18. commit

DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td>configure</td>
</tr>
<tr>
<td><strong>Step 2</strong></td>
<td>flow exporter-map fem-name</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>RP/0/RSP0/CPU0:router(config)# flow exporter-map fem</td>
</tr>
<tr>
<td><strong>Note</strong></td>
<td>A single flow monitor map can support up to eight exporters.</td>
</tr>
<tr>
<td><strong>Step 3</strong></td>
<td>destination location</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>RP/0/RSP0/CPU0:router(config-fem)# destination 10.0.1.2</td>
</tr>
<tr>
<td><strong>Step 4</strong></td>
<td>version v9</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>RP/0/RSP0/CPU0:router(config-fem)# version v9</td>
</tr>
<tr>
<td><strong>Step 5</strong></td>
<td>commit</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>RP/0/RSP0/CPU0:router(config-fem-ver)# commit</td>
</tr>
<tr>
<td><strong>Step 6</strong></td>
<td>exit</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>RP/0/RSP0/CPU0:router(config-fem-ver)# exit</td>
</tr>
<tr>
<td><strong>Step 7</strong></td>
<td>flow monitor-map map-name</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>RP/0/RSP0/CPU0:router(config)# flow monitor-map mmap</td>
</tr>
<tr>
<td><strong>Step 8</strong></td>
<td>record ipv4</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>RP/0/RSP0/CPU0:router(config-fmm)# record ipv4</td>
</tr>
</tbody>
</table>

Configuring NetFlow for the OpenFlow Agent

8. record ipv4
9. exporter map-name
10. cache entries number
11. cache timeout {active timeout-value | inactive timeout-value | update timeout-value}
12. commit
13. exit
14. sampler-map map-name
15. random 1 out-of sampling-interval
16. commit
17. exit
18. commit

DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td>configure</td>
</tr>
<tr>
<td><strong>Step 2</strong></td>
<td>flow exporter-map fem-name</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>RP/0/RSP0/CPU0:router(config)# flow exporter-map fem</td>
</tr>
<tr>
<td><strong>Note</strong></td>
<td>A single flow monitor map can support up to eight exporters.</td>
</tr>
<tr>
<td><strong>Step 3</strong></td>
<td>destination location</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>RP/0/RSP0/CPU0:router(config-fem)# destination 10.0.1.2</td>
</tr>
<tr>
<td><strong>Step 4</strong></td>
<td>version v9</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>RP/0/RSP0/CPU0:router(config-fem)# version v9</td>
</tr>
<tr>
<td><strong>Step 5</strong></td>
<td>commit</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>RP/0/RSP0/CPU0:router(config-fem-ver)# commit</td>
</tr>
<tr>
<td><strong>Step 6</strong></td>
<td>exit</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>RP/0/RSP0/CPU0:router(config-fem-ver)# exit</td>
</tr>
<tr>
<td><strong>Step 7</strong></td>
<td>flow monitor-map map-name</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>RP/0/RSP0/CPU0:router(config)# flow monitor-map mmap</td>
</tr>
<tr>
<td><strong>Step 8</strong></td>
<td>record ipv4</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>RP/0/RSP0/CPU0:router(config-fmm)# record ipv4</td>
</tr>
<tr>
<td>Step 9</td>
<td>exporter map-name</td>
</tr>
<tr>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td><strong>Purpose</strong></td>
<td>Associates an exporter map with a monitor map.</td>
</tr>
<tr>
<td><strong>Note</strong></td>
<td>A single flow monitor map can support up to eight exporters.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Step 10</th>
<th>cache entries number</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Purpose</strong></td>
<td>(Optional) Configures the number of entries in the flow cache. Replace the number argument with the number of flow entries allowed in the flow cache, in the range from 4096 through 1000000. The default number of cache entries is 65535.</td>
</tr>
</tbody>
</table>

| Step 11 | cache timeout {active timeout-value | inactive timeout-value | update timeout-value} |
|---|---|
| **Purpose** | (Optional) Configures the active, inactive, or update flow cache timeout value. |
| Example: | RP/0/RSP0/CPU0:router(config-fmm)# cache timeout active 10 |
| **Note** | • The default timeout value for the inactive flow cache is 15 seconds. |
| | • The default timeout value for the active flow cache is 1800 seconds. |
| | • The default timeout value for the update flow cache is 1800 seconds. |
| **Note** | The update keyword and timeout-value argument are used for permanent caches only. It specifies the timeout value that is used to export entries from permanent caches. In this case, the entries are exported but remain the cache. |

<table>
<thead>
<tr>
<th>Step 12</th>
<th>commit</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Purpose</strong></td>
<td>Commits the configuration changes to running to the running configuration.</td>
</tr>
<tr>
<td>Example:</td>
<td>RP/0/RSP0/CPU0:router(config-fmm)# commit</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Step 13</th>
<th>exit</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Purpose</strong></td>
<td>Exits flow monitor map version configuration mode and enters global configuration mode.</td>
</tr>
<tr>
<td>Example:</td>
<td>RP/0/RSP0/CPU0:router(config-fmm)# exit</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Step 14</th>
<th>sampler-map map-name</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Purpose</strong></td>
<td>Creates a sampler map and enters sampler map configuration mode.</td>
</tr>
<tr>
<td><strong>Note</strong></td>
<td>When configuring a sampler map, be aware that NetFlow supports policing at a rate of 35,000 packets per second per direction for each individual line card.</td>
</tr>
</tbody>
</table>

| Example: | RP/0/RSP0/CPU0:router(config)# sampler-map |
## Configuring Open Flow Agent

### Configuration Examples: Openflow

### Attaching a bridge domain to an Openflow Switch: Examples

- **Attaching a L2-only Openflow switch**

  ```
  openflow
  switch 1 pipeline 129
  tls trust-point local tp1 remote tp1
  bridge-group SDN-2 bridge-domain OF-2
  controller ipv4 5.0.1.200 port 6653 security tls
  ```

- **Attaching a L2_L3 Openflow switch**

  ```
  openflow
  switch 1 pipeline 130
  tls trust-point local tp1 remote tp1
  bridge-group SDN-2 bridge-domain OF-2
  controller ipv4 5.0.1.200 port 6653 security tls
  ```

- **L3_V4 switch** can be attached either to a VRF or directly to layer 3 interfaces under global VRF. In case of VRF, all the interfaces in that VRF become part of the OpenFlow switch.

  ```
  openflow
  switch 11 pipeline 131
  vrf IPv4
  controller ipv4 5.0.1.200 port 6653 security none
  ```

---

<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>random 1 out-of $sampling-interval$</td>
<td>Configures the sampling interval to use random mode for sampling packets. For the $sampling-interval$ argument, specify a number from 1 to 65535.</td>
</tr>
<tr>
<td>16</td>
<td>commit</td>
<td>Commits the configuration changes to running to the running configuration.</td>
</tr>
<tr>
<td>17</td>
<td>exit</td>
<td>Exits sampler map version configuration mode and enters global configuration mode.</td>
</tr>
<tr>
<td>18</td>
<td>commit</td>
<td></td>
</tr>
</tbody>
</table>

**What to do next**

Go to the “Associating the OpenFlow Agent Logical Switch with NetFlow” section to complete the second part of this configuration.
- L3_DS switch can be attached either to a VRF or directly to layer 3 interfaces under global VRF.

```plaintext
openflow
switch 12 pipeline 132
vrf IPv4
  controller ipv4 5.0.1.200 port 6653 security none
!
```

**OpenFlowAgent with NetFlow Collection and Analytics Configuration: Example**

The following example describes the NetFlow exporter map configuration for the OpenFlow logical switch.

```
Device> enable
Device# configure terminal
Device(config)# flow exporter-map fem
Device(config-fem)# destination 10.0.1.2
Device(config-fem)# version v9
Device(config-fem-ver)# commit
Device(config-fem-ver)# exit
```

The following example describes the NetFlow monitor map configuration for the OpenFlow logical switch.

```
Device(config)# flow monitor-map mmap
Device(config-fmm)# record ipv4
Device(config-fmm)# exporter fmap
Device(config-fmm)# cache entries 4096
Device(config-fmm)# commit
Device(config-fmm)# exit
```

The following example describes the NetFlow sampler map configuration for the OpenFlow logical switch.

```
Device(config)# sampler-map
Device(config-sm)# random 1 out-of 65535
Device(config-sm)# commit
Device(config-sm)# exit
```

The following example describes how the OpenFlow Agent logical switch is configured so that the NetFlow collection and analytics are associated with it.

```
Device(config)# openflow switch 100 netflow
Device(logical-switch)# flow monitor mmap sampler smap
Device(logical-switch)# interface GigabitEthernet0/1/0/6
Router(logical-switch)# controller 10.0.1.2 port 6633
Device(logical-switch)# commit
Device(logical-switch)# end
```

The following example describes `show` command output for an OpenFlow Agent logical switch that is configured with NetFlow collection and analytics.

```
Device# show openflow switch 100
Fri Jan 25 14:29:21.078 UTC
```
Logical Switch Context

Id: 100
Switch type: Netflow
Layer: NONE
Signal version: Openflow 1.0
Data plane: secure
Fallback: normal
Config state: no-shutdown
Working state: enabled
TLS version: NONE
TLS private key: none:none
TLS private key file: NONE
TLS certificate file: NONE
Netflow Monitor: mmap
Netflow Sampler: smap
Loopback i/f: <none>
Loopback addr: <none>
Interfaces:
    GigabitEthernet0/1/0/6

Device# show openflow switch 100 flows
Fri Jan 25 14:29:24.787 UTC
Logical Openflow Switch [100]:
NXST_FLOW reply (xid=0x0):
cookie=0x0, duration=204.729s, table=0, n_packets=0, n_bytes=0, priority=500 actions=netflow

Switch flow count: 1

Device# show openflow switch 100 controllers
Fri Jan 25 14:29:28.660 UTC
Logical Openflow Switch [100]:
    Controller [tcp:10.0.1.2:6633]
        role : Other
        connected : Yes
        state : ACTIVE
        sec_since_connect : 487

Usecase for Layer2

The Scenario: Enterprise Data Center needs to perform data backup to multiple other backup sites based on the Traffic flow. The Main DC is in Vlan 100 and Backup sites are at VLAN 1000,1001,1002. These Sites are interconnected through L2VPN.

The Solution: Openflow, we can match any Layer 2 header field (in this example we have taken priority bits) and steer the traffic to go on any L2 interconnect and also rewrite the VLANs appropriately.

Usecase for Layer3

The Scenario: Three different flows from 3 different sites connected to PE1 are trying to send 350 mbps of traffic each to PE2. The bandwidth of the shortest link, Path-2 (between PE1 and PE2) is only 1 Gigabit. Hence Path-2 gets congested as soon as the third site begins to send traffic.

The Solution: Openflow controller can be used to install rules on PE1:
• Match on Flow 1 (destined to Video server) and redirect traffic to Path-2
• Match on Flow 2 (destined to Web server) and redirect traffic to Path-1
• Match on Flow 3 (destined to File transfer server) and redirect traffic to Path-3

The Inference: Effectively utilizing the network bandwidth by redirecting destination specific traffic using OpenFlow rules.
CHAPTER 17

Configuring Call Home

This module describes the configuring of the Call Home feature.

Table 39: Feature History for Configuring Call Home

<table>
<thead>
<tr>
<th>Release</th>
<th>Modification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Release 4.1.0</td>
<td>Call Home was introduced</td>
</tr>
</tbody>
</table>

This model contains the following topics:

- About Call Home, on page 321
- Configuring Call Home, on page 325
- Configuring Contact Information, on page 326
- Configuring and Activating Destination Profiles, on page 327
- Associating an Alert Group with a Destination Profile, on page 329
- Configuring Email, on page 331
- Enabling Call Home, on page 333
- Configuring Smart Call Home (single command), on page 334
- Configuring Call Home Data Privacy, on page 334
- Configuring Syslog Throttling, on page 335
- Enabling AAA Authorization, on page 335
- Sending Call Home Alert group Messages Manually, on page 336
- Manually sending command output message for a Command List, on page 337
- Configuring a HTTP Proxy Server, on page 338
- Configuring Snapshot alert group, on page 339
- Configuring Anonymous Reporting, on page 339
- Configuring Call Home to use VRF, on page 340
- Configuring Source Interface, on page 341

About Call Home

Call Home provides an email and http/https based notification for critical system policies. A range of message formats are available for compatibility with pager services or XML-based automated parsing applications. You can use this feature to page a network support engineer, 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.

The Call Home feature can deliver alerts to multiple recipients, referred to as Call Home destination profiles. Each profile includes configurable message formats and content categories. A predefined destination is provided for sending alerts to the Cisco TAC, but you also can define your own destination profiles. When you configure Call Home to send messages, the appropriate CLI show command is executed and the command output is attached to the message. Call Home messages are delivered in the following formats:

- Short text format which provides a one or two line description of the fault that is suitable for pagers or printed reports.
- Full text format which provides fully formatted message with detailed information that is suitable for human reading.

### Destination Profiles

A destination profile includes the following information:

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

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

The following predefined destination profiles are supported:

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

### Call Home Alert Groups

An alert group is a predefined subset of alerts or events that Call Home detects and reports to one or more destinations. Alert groups allow you to select the set of alerts that you want to send to a predefined or custom destination profile. Alerts are sent to e-mail destinations in a destination profile only if that alert belongs to one of the alert groups associated with that destination profile and if the alert has a Call Home message severity at or above the message severity set in the destination profile.
The following table lists supported alert groups and the default CLI command output included in Call Home messages generated for the alert group.

Table 40: Alert Groups and Executed Commands

<table>
<thead>
<tr>
<th>Alert Group</th>
<th>Description</th>
<th>Executed Commands</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environmental</td>
<td>Events related to power, fan, and environment-sensing elements such as temperature alarms.</td>
<td>show environment, show logging, show inventory, show environment trace, show diag</td>
</tr>
<tr>
<td>Inventory</td>
<td>Inventory status that is provided whenever a unit is cold booted, or when FRUs are inserted or removed. This alert is considered a noncritical event, and the information is used for status and entitlement.</td>
<td>admin show platform, admin show version, admin show diag, admin show inventory oid</td>
</tr>
<tr>
<td>Syslog</td>
<td>Events generated by specific interesting syslog messages</td>
<td>admin show version, admin show logging, admin show inventory</td>
</tr>
<tr>
<td>Configuration</td>
<td>User-generated request for configuration or configuration change event.</td>
<td>- show version&lt;br&gt;- show running config all&lt;br&gt;- show inventory&lt;br&gt;- show configuration history last 30&lt;br&gt;- show configuration commit changes last 1</td>
</tr>
<tr>
<td>Snapshot</td>
<td>This alert group can be configured for periodic notifications</td>
<td>By default, this alert group has no commands to be run. You can add the required commands that need to be run.</td>
</tr>
</tbody>
</table>

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

**Call Home Message Levels**

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

**Note**

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

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

**Table 41: Severity and syslog Level Mapping**

<table>
<thead>
<tr>
<th>Call Home Level</th>
<th>Keyword</th>
<th>syslog Level</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>Catastrophic</td>
<td>N/A</td>
<td>Network-wide catastrophic failure.</td>
</tr>
<tr>
<td>8</td>
<td>Disaster</td>
<td>N/A</td>
<td>Significant network impact.</td>
</tr>
<tr>
<td>7</td>
<td>Fatal</td>
<td>Emergency (0)</td>
<td>System is unusable.</td>
</tr>
<tr>
<td>6</td>
<td>Critical</td>
<td>Alert (1)</td>
<td>Critical conditions that indicate that immediate attention is needed.</td>
</tr>
<tr>
<td>5</td>
<td>Major</td>
<td>Critical (2)</td>
<td>Major conditions.</td>
</tr>
<tr>
<td>4</td>
<td>Minor</td>
<td>Error (3)</td>
<td>Minor conditions.</td>
</tr>
<tr>
<td>3</td>
<td>Warning</td>
<td>Warning (4)</td>
<td>Warning conditions.</td>
</tr>
<tr>
<td>2</td>
<td>Notification</td>
<td>Notice (5)</td>
<td>Basic notification and informational messages. Possibly independently insignificant.</td>
</tr>
<tr>
<td>1</td>
<td>Normal</td>
<td>Information (6)</td>
<td>Normal event signifying return to normal state.</td>
</tr>
<tr>
<td>0</td>
<td>Debugging</td>
<td>Debug (7)</td>
<td>Debugging messages.</td>
</tr>
</tbody>
</table>

**Obtaining Smart Call Home**

If you have a service contract directly with Cisco Systems, you can register your devices for the Smart Call Home service. Smart Call Home provides fast resolution of system problems by analyzing Call Home messages sent from your devices and providing background information and recommendations. For issues that can be identified as known, particularly GOLD diagnostics failures, Automatic Service Requests will be generated with the Cisco-TAC.

Smart Call Home offers the following features:

- Continuous device health monitoring and real-time diagnostic alerts.
- Analysis of Call Home messages from your device and, where appropriate, Automatic Service Request generation, routed to the appropriate TAC team, including detailed diagnostic information to speed problem resolution.
• Secure message transport directly from your device or through a downloadable Transport Gateway (TG) aggregation point. You can use a TG aggregation point in cases that require support for multiple devices or in cases where security requirements mandate that your devices may not be connected directly to the Internet.

• Web-based access to Call Home messages and recommendations, inventory and configuration information for all Call Home devices. Provides access to associated field notices, security advisories and end-of-life information.

You need the following items to register:

• The SMARTnet contract number for your device
• Your e-mail address
• Your Cisco.com ID

For more information about Smart Call Home, see the Smart Call Home page at this URL: https://supportforums.cisco.com/community/netpro/solutions/smart_services/smartcallhome

Anonymous Reporting

Smart Call Home is a service capability included with many Cisco service contracts and is designed to assist customers resolve problems more quickly. If you decide not to use Smart Call Home, you can still enable Anonymous Reporting to allow Cisco to securely receive minimal error and health information from the device. If you enable Anonymous Reporting, your customer identity will remain anonymous, and no identifying information is sent.

When Call Home is configured for anonymous reporting, only , inventory, and test messages are sent to Cisco. No identifying information is sent.

Note

When you enable Anonymous Reporting, you acknowledge your consent to transfer the specified data to Cisco or to vendors operating on behalf of Cisco (including countries outside the United States). Cisco maintains the privacy of all customers. For information about how Cisco treats personal information, see the Cisco Privacy Statement.

Configuring Call Home

The tasks in this module describe how to configure the sending of Call Home messages. The following steps are involved:

1. Assign contact information.
2. Configure and enable one or more destination profiles.
3. Associate one or more alert groups to each profile.
4. Configure the email server options.
5. Enable Call Home.
Configuring Contact Information

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

SUMMARY STEPS

1. configure
2. call-home
3. contact-email-addr email-address
4. (Optional) contract-id contract-id-string
5. (Optional) customer-id customer-id-string
6. (Optional) phone-number phone-number-string
7. (Optional) street-address street-address
8. (Optional) site-id site-id-string
9. commit
10. show call-home

DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> configure</td>
<td>Enters call home configuration mode.</td>
</tr>
<tr>
<td><strong>Step 2</strong> call-home</td>
<td>Configures the customer email address. Enter up to 200 characters in email address format with no spaces.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>RP/0/RSP0/CPU0:router(config) configuration mode.</td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong> contact-email-addr email-address</td>
<td>Configures the customer email address. Enter up to 200 characters in email address format with no spaces.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>RP/0/RSP0/CPU0:router(config-call-home) configuration mode.</td>
<td></td>
</tr>
<tr>
<td><strong>Step 4</strong> contract-id contract-id-string</td>
<td>Configures the contract ID. Enter up to 64 characters. If you include spaces, you must enclose the entry in quotes (&quot;&quot;).</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>RP/0/RSP0/CPU0:router(config-call-home) configuration mode.</td>
<td></td>
</tr>
<tr>
<td><strong>Step 5</strong> customer-id customer-id-string</td>
<td>Configures the customer ID. Enter up to 64 characters. If you include spaces, you must enclose the entry in quotes (&quot;&quot;).</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>RP/0/RSP0/CPU0:router(config-call-home) configuration mode.</td>
<td></td>
</tr>
</tbody>
</table>
### Configuring and Activating Destination Profiles

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

#### SUMMARY STEPS

1. configure
2. call-home
3. profile profile-name
4. destination address email email-address
5. destination message-size-limit max-size
6. destination preferred-msg-format {short-text | long-text | xml}
7. destination transport-method [ email | http ]
8. active
9. commit
10. show call-home profile {all | profile-name}
### Detailed Steps

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> configure</td>
<td>Enters call home configuration mode.</td>
</tr>
<tr>
<td><strong>Step 2</strong> call-home</td>
<td>Enters call home profile configuration mode to configure a new or existing profile.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>RP/0/RSP0/CPU0:router(config)# call-home</td>
<td></td>
</tr>
<tr>
<td>RP/0/RSP0/CPU0:router(config-call-home)#</td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong> profile profile-name</td>
<td>Configures an email address to which Call Home messages are sent for this profile.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>RP/0/RSP0/CPU0:router(config-call-home)# profile my_profile</td>
<td></td>
</tr>
<tr>
<td>RP/0/RSP0/CPU0:router(config-call-home-profile)#</td>
<td></td>
</tr>
<tr>
<td><strong>Step 4</strong> destination address email email-address</td>
<td>Configures the maximum size of Call Home messages for this profile. Values can be between 50 and 3145728 characters.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>RP/0/RSP0/CPU0:router(config-call-home-profile)# destination address email <a href="mailto:support_me@cisco.com">support_me@cisco.com</a></td>
<td></td>
</tr>
<tr>
<td><strong>Step 5</strong> destination message-size-limit max-size</td>
<td>Configures the message format for this profile. The default is xml.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>RP/0/RSP0/CPU0:router(config-call-home-profile)# destination message-size-limit 1000</td>
<td></td>
</tr>
<tr>
<td><strong>Step 6</strong> destination preferred-msg-format {short-text</td>
<td>long-text</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>RP/0/RSP0/CPU0:router(config-call-home-profile)# destination preferred-msg-format xml</td>
<td></td>
</tr>
<tr>
<td><strong>Step 7</strong> destination transport-method [email</td>
<td>http ]</td>
</tr>
<tr>
<td>Example:</td>
<td><strong>Note</strong> At least one destination profile must be active for Call Home messages to be sent.</td>
</tr>
<tr>
<td>RP/0/RSP0/CPU0:router(config-call-home-profile)# destination transport-method email</td>
<td></td>
</tr>
<tr>
<td><strong>Step 8</strong> active</td>
<td></td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>RP/0/RSP0/CPU0:router(config-call-home-profile)# active</td>
<td></td>
</tr>
</tbody>
</table>
## Associating an Alert Group with a Destination Profile

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

**Before you begin**
Use the `show call-home alert-group` command to view available alert groups.

### SUMMARY STEPS
1. `configure`
2. `call-home`
3. `profile profile-name`
4. `subscribe-to-alert-group environment` `severity` `severity-level`
5. `subscribe-to-alert-group inventory` `periodic` `daily | monthly day-of-month | weekly day-of-week` `hh:mm`
6. `subscribe-to-alert-group syslog` `severity` `severity-level | pattern` `string`
7. `subscribe-to-alert-group snapshot` `severity` `severity-level | pattern` `string`
8. `subscribe-to-alert-group configuration` `severity` `severity-level | pattern` `string`
9. `commit`

### DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td><code>configure</code></td>
</tr>
<tr>
<td><strong>Step 2</strong></td>
<td><code>call-home</code></td>
</tr>
</tbody>
</table>

Example:

```
RP/0/RSP0/CPU0:router(config)# call-home
RP/0/RSP0/CPU0:router(config-call-home)#
```

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 3</strong></td>
<td><code>profile profile-name</code></td>
</tr>
</tbody>
</table>

Example:

```
RP/0/RSP0/CPU0:router(config-call-home)# profile
my_profile
RP/0/RSP0/CPU0:router(config-call-home-profile)#
```
### Purpose

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

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
</table>
| **Step 4**

**subscribe-to-alert-group environment [severity severity-level]**

**Example:**

RP/0/RSP0/CPU0:router(config-call-home-profile)#

subscribe-to-alert-group environment severity major

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

| Step 5 | subscribe-to-alert-group inventory [periodic {daily | monthly day-of-month | weekly day-of-week} hh:mm]

**Example:**

RP/0/RSP0/CPU0:router(config-call-home-profile)#

subscribe-to-alert-group inventory periodic monthly 1 10:00

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

| Step 6 | subscribe-to-alert-group syslog severity severity-level pattern string

**Example:**

RP/0/RSP0/CPU0:router(config-call-home-profile)#

subscribe-to-alert-group syslog severity major pattern

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

  - **catastrophic**—Includes network-wide catastrophic events in the alert. This is the highest severity.
  - **critical**—Includes events requiring immediate attention (system log level 1).
  - **disaster**—Includes events with significant network impact.
### Configuring Call Home

**Purpose**
- **fatal**—Includes events where the system is unusable (system log level 0).
- **major**—Includes events classified as major conditions (system log level 2).
- **minor**—Includes events classified as minor conditions (system log level 3)
- **normal**—Specifies the normal state and includes events classified as informational (system log level 6). This is the default.
- **notification**—Includes events informational message events (system log level 5).
- **warning**—Includes events classified as warning conditions (system log level 4).

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

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>subscribe-to-alert-group snapshot severity severity-level pattern string</td>
<td>Configures a destination profile to receive messages for the snapshot alert group. Alerts with a severity the same or greater than the specified severity level are sent. You can specify a pattern to be matched in the syslog message. If the pattern contains spaces, you must enclose it in quotes (&quot;&quot;&quot;).</td>
</tr>
<tr>
<td>subscribe-to-alert-group configuration severity severity-level pattern string</td>
<td>Configures a destination profile to receive messages for the configuration alert group. Alerts with a severity the same or greater than the specified severity level are sent. You can specify a pattern to be matched in the syslog message. If the pattern contains spaces, you must enclose it in quotes (&quot;&quot;&quot;).</td>
</tr>
<tr>
<td>commit</td>
<td></td>
</tr>
</tbody>
</table>

### What to do next

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

### Configuring Email

Call Home messages are sent via email. You must configure your email server before Call Home messages can be sent.
### SUMMARY STEPS

1. configure
2. call-home
3. (Optional) sender from email-address
4. (Optional) sender reply-to email-address
5. mail-server address priority priority
6. rate-limit events-count
7. commit
8. show call-home mail-server status

### DETAILED STEPS

<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>configure</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>call-home</td>
<td>Enters call home configuration mode.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>RP/0/RSP0/CPU0:router(config)# call-home</td>
<td></td>
</tr>
<tr>
<td></td>
<td>RP/0/RSP0/CPU0:router(config-call-home)#</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>(Optional) sender from email-address</td>
<td>Specifies the email message “from” address.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>RP/0/RSP0/CPU0:router(config-call-home)# sender from <a href="mailto:my_email@cisco.com">my_email@cisco.com</a></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>(Optional) sender reply-to email-address</td>
<td>Specifies the email message “reply-to” address.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>RP/0/RSP0/CPU0:router(config-call-home)# sender reply-to <a href="mailto:my_email@cisco.com">my_email@cisco.com</a></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Required: mail-server address priority priority</td>
<td>Specifies the mail server to use to send Call Home messages. You can specify an IP address or mail server name. You can specify up to five mail servers to use. The server with the lower priority is tried first.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>RP/0/RSP0/CPU0:router(config-call-home)# mail-server 198.51.100.10 priority 1</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Required: rate-limit events-count</td>
<td>Specifies the maximum trigger rate per minute. The default is five events per minute and the maximum is also five.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>RP/0/RSP0/CPU0:router(config-call-home)# rate-limit 4</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>commit</td>
<td></td>
</tr>
</tbody>
</table>
Enabling Call Home

By default, the sending of Call Home messages is disabled. You must perform this task to enable the sending of Call Home messages.

**Before you begin**

Before enabling the sending of Call Home messages, you should complete the configuration tasks described in this module. Specifically, you must have enabled a destination profile for any Call Home messages to be sent.

**SUMMARY STEPS**

1. configure
2. call-home
3. service active
4. commit

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> configure</td>
<td>Enters call-home configuration mode.</td>
</tr>
<tr>
<td><strong>Step 2</strong> call-home</td>
<td>Enables the sending of Call Home messages.</td>
</tr>
</tbody>
</table>
| **Example:**
  - RP/0/RSP0/CPU0:router(config)# call-home
  - RP/0/RSP0/CPU0:router(config-call-home)# |
| **Step 3** service active | |
| **Example:**
  - RP/0/RSP0/CPU0:router(config-call-home)# service active |
| **Step 4** commit | |
Configuring Smart Call Home (single command)

SUMMARY STEPS

1. configure
2. call-home reporting { anonymous | contact-email email-address } [ http-proxy { address } port port-number ]

DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1 configure</td>
<td>Enables all call home basic configurations using a single command.</td>
</tr>
<tr>
<td>Step 2 call-home reporting { anonymous</td>
<td>contact-email email-address } [ http-proxy { address } port port-number ]</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>RP/0/RSP0/CPU0:router (config) # call-home reporting contact-email <a href="mailto:email@company.com">email@company.com</a></td>
<td></td>
</tr>
</tbody>
</table>

Configuring Call Home Data Privacy

SUMMARY STEPS

1. configure
2. call-home
3. data-privacy { level { normal | high } | hostname }

DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1 configure</td>
<td>Enters the call home configuration submode.</td>
</tr>
<tr>
<td>Step 2 call-home</td>
<td>Scrubs data from call-home message to protect the privacy of the user. The default data-privacy level is normal.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>RP/0/RSP0/CPU0:router(config) # call-home</td>
<td></td>
</tr>
<tr>
<td>Step 3 data-privacy { level { normal</td>
<td>high }</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>RP/0/RSP0/CPU0:router(config-call-home) # data-privacy level high</td>
<td></td>
</tr>
</tbody>
</table>

- **normal** - scrubs all normal level commands, such as password/username/ip/destination. 
- **high** - scrubs all normal level commands plus the IP domain name and IP address commands.
### Configuring Syslog Throttling

This task is used to enable or disable Call Home syslog message throttling and avoid sending repetitive Call Home syslog messages.

**SUMMARY STEPS**

1. configure
2. call-home
3. syslog-throttling

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1 configure</td>
<td></td>
</tr>
<tr>
<td>Step 2 call-home</td>
<td>Enters call home configuration submode.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>RP/0/RSP0/CPU0:router (config) # call-home</td>
</tr>
<tr>
<td>Step 3 syslog-throttling</td>
<td>Enables or disables Call Home syslog message throttling and avoids sending repetitive Call Home syslog messages. By default, syslog message throttling is enabled.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>RP/0/RSP0/CPU0:router (config-call-home) # syslog-throttling</td>
</tr>
</tbody>
</table>

### Enabling AAA Authorization

This task is used to enable AAA authorization for Call Home messages.

**SUMMARY STEPS**

1. configure
2. call-home
3. aaa-authorization [username username]

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1 configure</td>
<td></td>
</tr>
<tr>
<td>Step 2 call-home</td>
<td></td>
</tr>
<tr>
<td>Step 3 aaa-authorization</td>
<td></td>
</tr>
</tbody>
</table>
### DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1 configure</td>
<td></td>
</tr>
<tr>
<td>Step 2 call-home</td>
<td>Enters Call Home configuration mode.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Step 3 aaa-authorization</td>
<td>Enables AAA authorization. Specifies the username for authorization.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
</tbody>
</table>

#### Sending Call Home Alert group Messages Manually

This task is used to manually trigger Call Home alert group messages.

You can use the **call-home send** command to manually send a specific alert group message. Guidelines for the CLI options of the command:

- Only the snapshot, configuration, and inventory alert groups can be sent manually. Syslog alert groups cannot be sent manually.
- When you manually trigger a snapshot, configuration, or inventory alert group message and you specify a destination profile name, a message is sent to the destination profile regardless of the profile’s active status, subscription status, or severity setting.
- When you manually trigger a snapshot, configuration, or inventory alert group message and do not specify a destination profile name, a message is sent to all active profiles that have either a normal or periodic subscription to the specified alert group.

#### SUMMARY STEPS

1. call-home send alert-group snapshot [ profile name ]
2. call-home send alert-group configuration [ profile name ]
3. call-home send alert-group inventory [ profile name ]

#### DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1 call-home send alert-group snapshot [ profile name ]</td>
<td>Sends a snapshot alert group message to one destination profile if specified or to all subscribed destination profiles.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Step 2 call-home</td>
<td>Enters Call Home configuration mode.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Step 3 aaa-authorization</td>
<td>Enables AAA authorization. Specifies the username for authorization.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
</tbody>
</table>
**Manually sending command output message for a Command List**

You can use the `call-home send` command to execute a command or a list of commands and send the command output through HTTP or email protocol.

Guidelines when sending the output of a command:

- The specified command or list of commands can be any run command, including commands for all modules. The command must be contained in quotes (""").

- If the email option is selected using the “email” keyword and an email address is specified, the command output is sent to that address.

- If neither the email nor the HTTP option is specified, the output is sent in long-text format with the specified service request number to the Cisco TAC (attach@cisco.com).

- If neither the “email” nor the “http” keyword is specified, the service request number is required for both long-text and XML message formats and is provided in the subject line of the email.

- If the HTTP option is specified, the CiscoTAC-1 profile destination HTTP or HTTPS URL is used as the destination. The destination email address can be specified so that Smart Call Home can forward the message to the email address. The user must specify either the destination email address or an SR number but they can also specify both.

This task enables you to execute command and send the command output.

**SUMMARY STEPS**

1. `call-home send { cli command | cli list } [ email email msg-format { long-text | xml } ] | http { destination-email-address email } [ tac-request SR# ]`
### Configuring a HTTP Proxy Server

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

#### SUMMARY STEPS

1. configure
2. call-home
3. http-proxy  
   
   **proxy-server-name**  
   
   **port**  
   
   **port-number**

#### DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1 configure</td>
<td></td>
</tr>
</tbody>
</table>

---

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>call-home send</td>
<td>executes the CLI or CLI list and sends output via email or HTTP.</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- **{ cli command</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>
|                    | - **email email msg-format { long-text | xml } | http**  
|                    |        |
|                    | - **destination-email-address email** } ] [ tac-request SR# ] |
|                    |        |
|                    | - **email email msg-format { long-text | xml }**—If the email option is selected, the command output will be sent to the specified email address in long-text or XML format with the service request number in the subject. The email address, the service request number, or both must be specified. The service request number is required if the email address is not specified (default is attach@cisco.com for long-text format and callhome@cisco.com for XML format). |
|                    |        |
|                    | - **http { destination-email-address email }**—If the http option is selected, the command output will be sent to Smart Call Home backend server (URL specified in the CiscoTAC-1 profile) in XML format. destination-email-address email can be specified so that the backend server can forward the message to the email address. The email address, the service request number, or both must be specified. |
|                    |        |
|                    | - **tac-service-request SR#**—specifies the service request number. The service request number is required if the email address is not specified. |
### Configuring Call Home

#### Purpose

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 2</td>
<td></td>
</tr>
<tr>
<td><code>call-home</code></td>
<td>Enters Call Home configuration mode.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td><code>RP/0/RSP0/CPU0:router (config) # call-home</code></td>
<td></td>
</tr>
</tbody>
</table>

| Step 3                  |                                              |
| `http-proxy proxy-server-name port port-number` | Configures the port for the specified HTTP proxy server. Range is 1 to 65535. |
| Example:                |                                              |
| `RP/0/RSP0/CPU0:router (config) # http-proxy p1 port 100` |                                              |

### Configuring Snapshot alert group

#### SUMMARY STEPS

1. `configure`
2. `call-home`
3. `alert-group-configuration snapshot`
4. `add-command "command string"`

#### DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1</td>
<td></td>
</tr>
<tr>
<td><code>configure</code></td>
<td></td>
</tr>
</tbody>
</table>

| Step 2                  |                                              |
| `call-home`             | Enters Call Home configuration mode.         |
| Example:                |                                              |
| `RP/0/RSP0/CPU0:router (config) # call-home` |                                              |

| Step 3                  |                                              |
| `alert-group-configuration snapshot` | Enters snapshot configuration mode. |
| Example:                |                                              |
| `RP/0/RSP0/CPU0:router (config-call-home) # alert-group-configuration snapshot` |                                              |

| Step 4                  |                                              |
| `add-command "command string"` | Adds the command to the snapshot alert group. |
| Example:                |                                              |
| `RP/0/RSP0/CPU0:router (config-call-home-snapshot) # add-command "show ver"` |                                              |

### Configuring Anonymous Reporting

This task enables the user to configure an anonymous mode profile.
SUMMARY STEPS

1. configure
2. call-home
3. profile name
4. anonymous-reporting-only

DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>configure</td>
<td>Enters Call Home configuration mode.</td>
</tr>
<tr>
<td>call-home</td>
<td>Enters Call Home configuration mode. Example: RP/0/RSP0/CPU0:router (config) # call-home</td>
</tr>
<tr>
<td>profile name</td>
<td>Enters the profile configuration mode. Example: RP/0/RSP0/CPU0:router (config-call-home) # profile ciscotac</td>
</tr>
<tr>
<td>anonymous-reporting-only</td>
<td>Enters anonymous mode. When anonymous-reporting-only is set, only inventory and test messages are sent. Example: RP/0/RSP0/CPU0:router (config-call-home-profile) # anonymous-reporting-only</td>
</tr>
</tbody>
</table>

What to do next

Configure Call Home to use VRF

SUMMARY STEPS

1. configure
2. call-home
3. vrf vrf-name

DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>configure</td>
<td>Enters Call Home configuration mode.</td>
</tr>
<tr>
<td>call-home</td>
<td>Enters Call Home configuration mode. Example: RP/0/RSP0/CPU0:router (config) # call-home</td>
</tr>
</tbody>
</table>
Configuring Call Home

Purpose
Command or Action | Purpose
--- | ---
**Step 3** | **vrf vrf-name**
**Example:**  
RP/0/RSP0/CPU0:router (config) # vrf v1 | Configures call home for the specified VRF. VRF works only for the http transport method. It does not work for the email transport method.

---

## Configuring Source Interface

This task enables the user to configure a source interface.

**SUMMARY STEPS**

1. configure
2. call-home
3. source-interface type interface-path-id

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td>configure</td>
</tr>
</tbody>
</table>
| **Step 2** | call-home  
**Example:**  
RP/0/RSP0/CPU0:router (config) # call-home | Enters Call Home configuration mode. |
| **Step 3** | source-interface type interface-path-id  
**Example:**  
RP/0/RSP0/CPU0:router (config) # source-interface tengige 10.1.1.1 | Configures the source interface.  
**Note** Source-interface supports email and HTTP messages. |
Configuring Data Collection Manager

This module describes the configuring of the Data Collection Manager feature.

Table 42: Feature History for Configuring Data Collection Manager

<table>
<thead>
<tr>
<th>Release</th>
<th>Modification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Release 5.2.2</td>
<td>This feature was introduced</td>
</tr>
</tbody>
</table>

- Data Collection Manager, on page 343

Data Collection Manager

Cisco Data Collection Manager (DCM) is an efficient and reliable data collection agent that is embedded in managed devices, such as routers and switches. DCM works on a push model, which is based on a subscribe-and-notify data pattern, as opposed to the pull model, which is based on a request-and-response data pattern. The Data Collection Manager (DCM) supports advanced on-board data processing that includes baseline calculation, summary calculation, statistical distribution, and percentile computation.

Data Collection Manager and Bulkstat

The Data Collection Manager (DCM) and the bulkstat module are the vital units of a framework which enables the bulk collection mechanism to include multiple data sources and multiple data export mechanisms.

The Bulkstat client application is implemented using the DCM core services to retrieve data and export it to the user. The Bulkstat client provides the only available user interface for DCM access. The client also provides CLI access through a new set of configuration commands and MIB access through the CISCO-DATA-COLLECTION-MIB.

DCM provides data subscription service for different data sources (such as, SNMP MIB objects and show command outputs). It also provides data retrieval management and data filtering services. With DCM, one source can be allocated for periodically collecting all management data.

Bulkstat, is an application which will use DCM to provide the following:

- Profiles and data-groups for different data-sources.
- Data processing – Summary, Distribution, Percentile and Auto-baseline.
- Data exports – File.
Benefits of DCM

DCM is very useful for Data Retrieval and Export and Performance Management solutions. This list includes all the benefits of DCM.

- Data export and retrieval: The Data Collection Manager (DCM) provides data retrieval management to ensure that the data collection does not impact device resources. The DCM can export data in a file format using multiple export protocols such as FTP, TFTP, Secure copy protocol (SCP), and Secure File Transfer Protocol (SFTP). The DCM provides a query mechanism with which data can be selectively exported based on the configured time interval and other selection criteria. The DCM application also provides data filtering services and exports the filtered data. You can also set primary and secondary destinations for exporting the collected data in a raw or processed format. Snapshots of the collected data can be stored for later retrieval.

- Performance Management: The Data Collection Manager (DCM) can be used to manage various aspects of performance management. It can collect data with a high granularity to help the Network Management Server (NMS) make dynamic traffic engineering decisions. DCM can also be used to collect resource variables that are important for effective capacity trend information, such as memory, queue depth, broadcast volume, buffer, Frame Relay congestion notification, and backplane utilization.

- Troubleshooting: The streaming function of the DCM can be used for real-time troubleshooting.

- SLA: A service level agreement (SLA) includes a what-if analysis for network changes and application changes, a trend for defined performance variables, exception management for defined capacity and performance variables, and QoS management. The DCM can be used to collect periodic data for reporting purposes.

Bulkstat

Two challenges that network providers usually face are data gathering and data analysis. Network providers need to gather large volumes of data to analyze the performance of the network and to have operational control over their network. Large service providers are strengthening their data gathering and analysis infrastructure. Traditionally, Simple Network Management Protocol (SNMP) agents are used to expose management data on managed systems. But, SNMP is not well suited for gathering large volumes of data, especially over short time intervals. For example, service providers charge customers depending on the network usage. Also this data must be available on customer request. Accounting applications based on SNMP polling models consume significant network bandwidth because they poll large volumes of data frequently. The SNMP protocol data unit (PDU) is a complex data type specific to SNMP and is expensive to process because the SNMP objects and tables must be sorted in a lexicographic order. All the entries in SNMP MIB tables are lexicographically ordered by their object identifiers, because there is an implied ordering in the MIB based on the order of the object identifiers. In such cases, the need to continuously poll large or bulk SNMP statistics can be avoided by using applications known as collectors to retrieve data.

The Bulkstat application is one such collector that uses the services of the Data Collection Manager (DCM) to provide the following functions:

- Collecting SNMP MIB object values.
- Processing the collected data to create summary, percentiles, and auto-baselined values.
- Exporting collected data through simple file transfers.
• Scheduling calendar events for data collection and export.

The Bulkstat application provides command-line access through a set of new configuration commands and exclusive MIB access through CISCO-DATA-COLLECTION-MIB to collect SNMP data.

You can configure Bulkstat for the following functions:

• Specify the way Bulkstat retrieves bulk statistics.
• Specify the time interval in seconds at which Bulkstat transfers data to receivers.
• Specify the maximum size of the bulk statistics file.
• Specify the context, instance, and period at which the system retrieves bulk statistics.
• Configure file-related parameters.
• Configure the interface type on which you want to collect statistics.
• View the parameters that Bulkstat uses to collect statistics by using the show bulkstat commands.

**Bulkstat Configuration Elements**

The following list shows the elements that you can configure using the Bulkstat interface:

• Data set
• Instance set
• Filter set
• Data group
• Process set
• Data profile
• Calendar Scheduling

**Data Set**

This section describes the data set elements that you can configure to collect Simple Network Management Protocol (SNMP) data and CLI data. Only objects having the same index elements can be grouped in a single object list.

The SNMP data set contains the following fields:

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
<th>Configuration Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Objects</td>
<td>Specifies the object to be collected. Multiple objects can be configured to form a data set. The textual name of the object can be used for configuring an object. If the device does not recognize the textual name, the object identifier (OID) format can be used for configuring the name.</td>
<td>Mandatory</td>
</tr>
</tbody>
</table>
Filter Set

The CLI data set contains the following fields:

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
<th>Configuration Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Object Alias</td>
<td>Specifies the optional alias name that each object can have.</td>
<td>Optional</td>
</tr>
</tbody>
</table>

CLI

Specifies the CLI command for which the show output needs to be collected. More than one CLI can be specified in the same data set.

Mandatory

Filter Set

This section describes the filter configuration per object.

The filter set elements that you can configure to collect Simple Network Management Protocol (SNMP) data are described here. More than one filter of the same type can be added to the set.

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Object match</td>
<td>Specifies the value to be used to match against the value retrieved for the object during collection. The value provided needs to match the type of the object. If there is an error in the type matching, the configuration is not accepted. More than one value can be specified for an object, and more than one object can have matching values.</td>
<td>Optional</td>
</tr>
</tbody>
</table>

Instance Set

This section specifies the instance set elements that you can configure to collect Simple Network Management Protocol (SNMP) data. More than one instance of the same type can be added to the set. Combinations of types of instance set elements are not supported.

The SNMP Instance set contains the following fields:

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
<th>Configuration Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exact</td>
<td>Specifies the instance for which the data should be collected. More than one instance can be specified, but only fully qualified instances should be specified.</td>
<td>Optional</td>
</tr>
</tbody>
</table>
## Name | Description | Configuration Status
--- | --- | ---
Wildcard | Specifies all instances for all objects under the object configured in the data set. | Optional
Range | Specifies the start and end instances. All instances within the range, including the start and end, are collected, but only fully qualified instances should be specified. | Optional
Repetition | Specifies the start of the repetition and the number of repetitions. All instances from the start until the number of repetitions within the subtree are collected. | Optional
Interface | Specifies the interface instead of the index. The ifIndex assigned to the interface will be used as an index. This can be used for MIB objects indexed by ifindex. | Optional

### Process Set

Data processing allows users to derive information from raw SNMP data, by calculating summaries and percentiles. Service providers rely on monitored SNMP data to alert network management systems (NMSs) of changing network conditions. By periodically monitoring the device data and comparing it against a set of thresholds, the network can automatically alert the operators, thereby allowing efficient operations.

- **Summary**: You can enable summary processing on the collected object value and calculate minimum, maximum, and average values. A summary is calculated for only those objects that are marked as process capable in the data group and uses the absolute or delta value as per the object configuration.

- **Distribution**: You can enable distribution processing on the collected object value by specifying the object type, minimum value, maximum value, and the number of buckets to distribute the value. Based on the configuration, counters are maintained per bucket and are incremented whenever the data falls into a bucket range.

- **Percentile**: You can enable percentile processing on the collected object value. A percentile is calculated on every process interval expiry. Distribution configuration is mandatory to enable percentile processing. Percentile computation is done assuming that the distribution is normal.

- **Auto-baseline**: You can enable baseline processing on the collected object value. The baseline internally uses all summary, distribution, and percentile calculations to provide baseline values. You can configure either baseline processing or other forms of processing, such as summary, distribution, and percentile calculations. The auto-baseline feature in DCM calculates the baseline values for variables of interest on the device and allows network management applications or network operators to retrieve the baseline values. The baseline values can be displayed in terms of percentiles or a median with standard deviation.
Data Group

This section describes the data group, which contains the data-group name, data-group type, data set, instance set, filter set, polling interval, SNMP context, and other processing options.

The Data Group elements are:

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
<th>Configuration Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data</td>
<td>Specifies any one of the data types as defined in the topic Data Set.</td>
<td>Mandatory</td>
</tr>
<tr>
<td>Instance</td>
<td>Specifies any one of the instance types as defined in the topic Instance Set.</td>
<td>Optional, if not specified. Only applicable for SNMP.</td>
</tr>
<tr>
<td>Filter</td>
<td>Specifies any one of the filter types as defined in the topic Filter Set.</td>
<td>Optional, if not specified. Only applicable for SNMP.</td>
</tr>
<tr>
<td>Polling Interval</td>
<td>Specifies the collection periodic interval in seconds. In case of recurring collection, the data is collected at the expiration of the collection interval until the collection is stopped.</td>
<td>Optional</td>
</tr>
<tr>
<td>Context</td>
<td>Specifies the management context from which to obtain data for this data group.</td>
<td>Optional</td>
</tr>
<tr>
<td>Process Summary</td>
<td>Enables summary processing of the data marked to be processed in the corresponding data-set configuration.</td>
<td>Optional</td>
</tr>
<tr>
<td>Process Distribution</td>
<td>Enables distribution processing of the data marked to be processed in the corresponding data-set configuration.</td>
<td>Optional</td>
</tr>
<tr>
<td>Process Percentile</td>
<td>Enables percentile processing of the data marked to be processed in the corresponding data-set configuration.</td>
<td>Optional</td>
</tr>
<tr>
<td>Name</td>
<td>Description</td>
<td>Configuration Status</td>
</tr>
<tr>
<td>-----------------------</td>
<td>------------------------------------------------------------------------------</td>
<td>----------------------</td>
</tr>
<tr>
<td>Process Auto-baseline</td>
<td>Enables auto-baselining processing of the data marked to be processed in the corresponding data-set configuration. If auto-baseline process is enabled, the other processes, such as summary, distribution, and percentile configurations, if done previously, are removed because auto-baseline process uses these functionalities internally. <strong>Note</strong> Removing this configuration will not reinstate the other configurations that are removed.</td>
<td>Optional</td>
</tr>
<tr>
<td>Discard raw</td>
<td>Specifies whether to store raw data. If data is processed, the user can choose to store only process data by setting the option.</td>
<td>Optional</td>
</tr>
</tbody>
</table>

**Data Profile**

This section describes the data profile that is used to group multiple data groups. This is done to simplify the configuration and to aggregate data of similar nature. A data profile can have multiple data groups. A data group can have constraints in the data specified in the element. If two sets of data need to be written to the same file, the respective data groups should be linked as part of a single profile.

The Data Profile has these fields:

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data groups</td>
<td>Specifies the data group to be linked to this profile. Multiple data groups can be linked to a single profile.</td>
<td>Mandatory before activating a profile</td>
</tr>
<tr>
<td>Transfer Interval</td>
<td>Specifies the transfer periodic interval in seconds. In case of recurring transfer, the data is transferred when the transfer interval expires.</td>
<td>Optional</td>
</tr>
<tr>
<td>Name</td>
<td>Description</td>
<td>Status</td>
</tr>
<tr>
<td>-------------------</td>
<td>-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>---------</td>
</tr>
<tr>
<td>Process Interval</td>
<td>Specifies the process periodic interval in seconds. The data is processed during every collection interval as soon as it is collected. When the process interval expires, the processed data is written into a file and transferred.</td>
<td>Optional</td>
</tr>
<tr>
<td>Primary URL</td>
<td>Specifies the URL of the primary management station. The files containing the collected data are transferred to this URL when the transfer interval expires.</td>
<td>Mandatory</td>
</tr>
<tr>
<td>Secondary URL</td>
<td>Specifies the URL of the secondary management station to be used in case the transfer to the primary management station fails.</td>
<td>Optional</td>
</tr>
<tr>
<td>Schema</td>
<td>Specifies the file data format. The schema ASCII option is supported.</td>
<td>Optional</td>
</tr>
<tr>
<td>Retry</td>
<td>Specifies the number of times that the transfer is retried in case of transfer failures to both primary and secondary management stations. This command has an effect only if the retain command is configured in the profile. The retry interval is computed by dividing the retention time by the number of retries. For example, if the file is retained for 60 minutes and the retry is 6 times, the transfer is attempted every 10 minutes, until the transfer succeeds or the file is removed.</td>
<td>Optional</td>
</tr>
<tr>
<td>Buffer-size</td>
<td>Specifies the maximum size to which the file containing the collected data can grow. When it reaches the limit, the file is closed and the transfer is attempted based on the transfer configuration associated with the data group or profile.</td>
<td>Optional</td>
</tr>
<tr>
<td>Retention Memory</td>
<td>Specifies the time, in seconds, to retain the file in the memory.</td>
<td>Optional</td>
</tr>
</tbody>
</table>
### Calendar Scheduling

The Bulkstat application allows you to schedule each subscription for collection. A subscription can be scheduled for one-time collection or periodic collection. A periodic subscription can be repeated infinitely or for a specified number of repetitions. A timer is instantiated for every activated subscription.

The calendar scheduling elements are:

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
<th>Configuration Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>One shot</td>
<td>Specifies that the data is collected for a specified collection interval.</td>
<td>Optional</td>
</tr>
<tr>
<td>Recurring</td>
<td>Specifies that the data is collected regularly at the specified time, day, month, and for a specified collection interval.</td>
<td>Optional</td>
</tr>
</tbody>
</table>

### File Data Export

The file data export feature on the Data Collection Manager (DCM) exports the collected data based on the transfer configurations. Data can be exported in various formats, and Bulkstat files are one such format to collect data. The format in which the data is inserted into the file conforms to the schema-Ascii format described in CISCO-DATA-COLLECTION-MIB and CISCO-BULK-FILE-MIB. The data sequence in which the data is stored is determined based on the sequence in which the data is received.

The Cisco File Transfer module is responsible for transferring the files as per the transfer configuration. A file can be retained in the device whether the transfer was a success or a failure.

### Configuring an SNMP Bulkstat Data Set

The first step in configuring the Simple Network Management Protocol (SNMP) periodic data collection and transfer mechanism is to configure one or more data sets. A data set is used to group objects of similar types, based on the data source. The data set is defined outside of the data group. This external definition gives the user the flexibility to use the same data set across multiple data groups and to collect the output for different instances and different contexts.

All objects in an SNMP data set must be indexed by the same MIB index. However, the objects in the data set must not belong to the same MIB or the MIB table.

Perform this task to configure the SNMP Bulkstat data set.

#### SUMMARY STEPS

1. `configure`
2. `bulkstat data data-set -name type snmp`
3. **object oid [ alias alias-name ]**

## DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td>configure</td>
</tr>
</tbody>
</table>
| **Step 2** | bulkstat data data-set-name type snmp  
*Example:*  
RP/0/RSP0/CPU0:router (config) # bulkstat data interface-stats type snmp | Defines an SNMP Bulkstat data set and enters SNMP bulk statistics data set configuration mode. The creation of an SNMP Bulkstat data set creates a row in the cdcDGBaseObjectEntry table in the SNMP MIB.  
| **Step 3** | object oid [ alias alias-name ]  
*Example:*  
RP/0/RSP0/CPU0:router (config-bs-ds-snmp) # object 1.3.6.1.2.1.2.2.1.10 alias ifInOctets | Adds a MIB object to the SNMP Bulkstat data set. If the object is already present in the data set, this command replaces the old object configuration with the new configuration.  
*Note* Repeat this command until all objects to be monitored are added to this list. |

### Configuring an SNMP Bulkstat Filter Set

The Simple Network Management Protocol (SNMP) filter set specifies the filter configuration for every SNMP object.

Perform this task to configure the SNMP Bulkstat filter set.

### SUMMARY STEPS

1. **configure**  
2. **bulkstat filter filter-set-name**  
3. **match object-name { eq line | start line | not { eq line | start line } }**

### DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td>configure</td>
</tr>
</tbody>
</table>
| **Step 2** | bulkstat filter filter-set-name  
*Example:*  
RP/0/RSP0/CPU0:router (config) # bulkstat filter ifType | Defines an SNMP Bulkstat filter set and enters SNMP bulk statistics filter set configuration mode.  
| **Step 3** | match object-name { eq line | start line | not { eq line | start line } }  
*Example:*  
RP/0/RSP0/CPU0:router (config-bs-fs) # match ifType eq 6767 | (Optional) Specifies a value to be used to match against the value retrieved for the object during collection.  
*Note* More than one value can be specified for an object, and more than one object can have match values. |
Configuring an SNMP Bulkstat Instance Set

The Simple Network Management Protocol (SNMP) instance set specifies the instances for which the data should be collected. Each subscription can collect different entries for specified objects based on the instance configuration. While more than one instance of the same type can be added to the instance set, a combination of different types is not supported.

Perform this task to configure the SNMP Bulkstat instance set.

**SUMMARY STEPS**

1. configure
2. bulkstat instance **instance-set -name** type **snmp**
3. exact **oid** **oid**
4. exact interface **interface-id**
5. wildcard
6. wildcard **oid** **oid**
7. wildcard interface **interface-id**
8. repetition **oid** **max value**
9. range start **oid** end **oid**

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td>configure</td>
</tr>
</tbody>
</table>
| **Step 2** bulkstat instance **instance-set -name** type **snmp** | Defines an SNMP Bulkstat instance set and enters SNMP Bulkstat instance set configuration mode. The creation of an SNMP Bulkstat instance set creates a row in the cdcDGInstanceEntry table in the SNMP MIB.  
  **Note** An instance created using this command can be linked to more than one data group. |
| **Example:** RP/0/RSP0/CPU0:router (config) # bulkstat instance exact type snmp | |
| **Step 3** exact **oid** **oid** | (Optional) Indicates that the specified instance, when appended to the object list, is the complete OID. |
| **Example:** RP/0/RSP0/CPU0:router (config-bs-is-snmp) # exact oid 1 | |
| **Step 4** exact interface **interface-id** | (Optional) Specifies an interface name and number, for example interface Ethernet 0, instead of specifying the ifIndex OID for the interface. |
| **Example:** RP/0/RSP0/CPU0:router (config-bs-is-snmp) # exact interface Ethernet0/0 sub-if | |
| **Step 5** wildcard | (Optional) Specifies whether an object used for evaluating an expression should be made a wildcard during an event configuration. |
| **Example:** RP/0/RSP0/CPU0:router (config-bs-is-snmp) # wildcard | |
Configuring a Bulkstat Data Group

The Bulkstat data group element is used to group the data set, filter set, and instance set and also to specify the processing options.

Perform this task to configure the Bulkstat data group.

**SUMMARY STEPS**

1. configure
2. bulkstat data-group data-group-name
3. collect type { command | expression } date date-set-name filter filter-set-name | snmp { data data-set-name instance instance-set-name filter filter-set-name } }
4. context context-name
5. interval polling polling-interval
6. discard
7. process

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1 configure</td>
<td></td>
</tr>
<tr>
<td>Step 2 bulkstat data-group data-group-name</td>
<td>Defines a Bulkstat data group and enters Bulkstat data group configuration mode.</td>
</tr>
</tbody>
</table>

---

### Command or Action

<table>
<thead>
<tr>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Optional) Indicates that all subindices of the specified OID belong to this schema.</td>
</tr>
<tr>
<td>(Optional) Specifies an interface name and number, for example interface Ethernet 0, instead of specifying the ifIndex OID for the interface.</td>
</tr>
<tr>
<td>(Optional) Configures data collection to repeat get-next for the maximum number of instances starting from the specified oid instance.</td>
</tr>
<tr>
<td>(Optional) Configures a range of instances for which the data is collected.</td>
</tr>
</tbody>
</table>
Configuring Data Collection Manager

## Configuring a Bulkstat Profile

Perform this task to configure the Bulkstat Profile.

The profile element is used to group multiple data groups. This grouping simplifies the configuration and aggregates data of a similar nature. If two sets of data need to be written to the same file, the respective data groups should be linked as part of a single profile.

### SUMMARY STEPS

1. **configure**
2. **bulkstat profile** profile-name
3. **data-group** data-group name
4. **interval transfer** { process | raw } seconds
5. **file-format** schema ASCII
6. **file retain** { disk url | memory seconds }

---

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>RP/0/RSP0/CPU0:router (config) # bulkstat data-group if-dg</td>
<td>The creation of a Simple Network Management Protocol (SNMP) Bulkstat data group creates a row in the cdcDGEentry table in the SNMP MIB.</td>
</tr>
</tbody>
</table>

### Step 3

**collect type** { { command | expression } date date-set-name filter filter-set-name } | **snmp** { data data-set-name instance instance-set-name filter filter-set-name } |

**Example:**

```
RP/0/RSP0/CPU0:router (config-bs-dg) # collect type snmp data interface-stats instance ins-exact filter ifType
```

Specifies the collection type to collect data from different sources for this data group.

### Step 4

**context** context-name |

**Example:**

```
RP/0/RSP0/CPU0:router (config-bs-dg) # context ctx-name
```

Specifies the management context from which to obtain data for this data group.

### Step 5

**interval polling** polling-interval

**Example:**

```
RP/0/RSP0/CPU0:router (config-bs-dg) # interval polling 100
```

Specifies the collection periodic interval in seconds. In case of recurring collection, the data is collected at the expiration of the collection interval until the collection is stopped.

### Step 6

**discard** |

**Example:**

```
RP/0/RSP0/CPU0:router (config-bs-dg) # discard
```

Specifies whether to discard the raw data.

### Step 7

**process** |

**Example:**

```
RP/0/RSP0/CPU0:router (config-bs-dg) # process
```

Configures process-related parameters for a data group.
### DETAILED STEPS

<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>configure</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td><code>bulkstat profile profile-name</code></td>
<td>Creates a profile with the given name and enters Bulkstat profile configuration mode. If the profile is already created, this command sets the context for the existing profile.</td>
</tr>
<tr>
<td>3</td>
<td><code>data-group name</code></td>
<td>Specifies the data group to be linked to this profile. Multiple data groups can be linked to a single profile.</td>
</tr>
<tr>
<td>4</td>
<td>`interval transfer { process</td>
<td>raw } seconds`</td>
</tr>
<tr>
<td>5</td>
<td><code>file-format schema ASCII</code></td>
<td>Configures the file-related parameter for a profile. Specifies the file data format in ASCII.</td>
</tr>
<tr>
<td>6</td>
<td>`file retain { disk url</td>
<td>memory seconds }`</td>
</tr>
<tr>
<td>7</td>
<td><code>file size bytes</code></td>
<td>Configures the file-related size parameter for a profile.</td>
</tr>
<tr>
<td>8</td>
<td>`file transfer { retry number</td>
<td>url { primary url</td>
</tr>
</tbody>
</table>

---

**Purpose of Each Step:**

- **Step 1:** Configure the Bulkstat profile.
- **Step 2:** Create a profile with the given name and enter Bulkstat profile configuration mode.
- **Step 3:** Specify the data group to be linked to the profile.
- **Step 4:** Set the transfer periodic interval in seconds.
- **Step 5:** Configure the file-related parameter for a profile.
- **Step 6:** Specify the file retain parameter.
- **Step 7:** Configure the file-related size parameter for a profile.
- **Step 8:** Configure the file-related transfer parameter for a profile.
### Configuring Bulkstat Calendar Scheduling

**SUMMARY STEPS**

1. `configure`
2. `bulkstat schedule schedule at time-detail { oneshot | recurring }
3. `profile profile-name start { oneshot | recurring number }
4. `profile profile-name stop`

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td><code>configure</code></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>`bulkstat schedule schedule at time-detail { oneshot</td>
<td>recurring }`</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td><code>RP/0/RSP0/CPU0:router (config) # bulkstat schedule event1 at 11:30 jan 10 oneshot</code></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>`profile profile-name start { oneshot</td>
<td>recurring number }`</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td><code>RP/0/RSP0/CPU0:router (config-bs-schedule) # profile cpu-process start recurring 5</code></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td><code>profile profile-name stop</code></td>
<td>Disables the profile.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td><code>RP/0/RSP0/CPU0:router (config-bs-schedule) # profile cpu-process stop</code></td>
<td></td>
</tr>
</tbody>
</table>

### Configuration Examples and Usecase Scenarios

The usecase scenarios with examples are discussed here.
Usecase-1: Collecting MIB Statistics

Goal: To collect IF MIB Statistics

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step1: Identifying the inputs and other parameters</td>
<td>MIB Objects of interest:</td>
</tr>
<tr>
<td></td>
<td>• 1.3.6.1.2.1.2.1.2 (ifDescr)</td>
</tr>
<tr>
<td></td>
<td>• 1.3.6.1.2.1.2.1.10 (ifInOctets)</td>
</tr>
<tr>
<td></td>
<td>• 1.3.6.1.2.1.2.1.16 (ifOutOctets)</td>
</tr>
<tr>
<td></td>
<td>Export Parameters:</td>
</tr>
<tr>
<td></td>
<td>• Interval: 60 seconds</td>
</tr>
<tr>
<td></td>
<td>• Protocol: TFTP</td>
</tr>
<tr>
<td></td>
<td>• Server: 10.105.33.135</td>
</tr>
<tr>
<td></td>
<td>• Path: dcm_data</td>
</tr>
<tr>
<td>Step2: Configuring the Data set if-mib</td>
<td>bulkstat data if-mib type snmp object 1.3.6.1.2.1.2.1.2 object 1.3.6.1.2.1.2.1.10 object 1.3.6.1.2.1.2.1.16</td>
</tr>
<tr>
<td>For detailed procedure:</td>
<td>Configuring an SNMP Bulkstat Data Set, on page 351</td>
</tr>
<tr>
<td>Step3: Configuring the Instance set if-mib</td>
<td>bulkstat instance if-mib type snmp wildcard</td>
</tr>
<tr>
<td>For detailed procedure:</td>
<td>Configuring an SNMP Bulkstat Instance Set, on page 353</td>
</tr>
<tr>
<td>Step4: Configuring Data Group if-group</td>
<td>bulkstat data-group if-group interval polling 30 collect type snmp data if-mib instance if-mib</td>
</tr>
<tr>
<td>For detailed procedure:</td>
<td>Configuring a Bulkstat Data Group, on page 354</td>
</tr>
<tr>
<td>Step5: Configuring Profile snmp_profile</td>
<td>bulkstat profile snmp_profile file transfer url primary tftp://10.105.33.135/dcm_data/ interval transfer raw 60 data-group if-group enable</td>
</tr>
<tr>
<td>For detailed procedure:</td>
<td>Configuring a Bulkstat Profile, on page 355</td>
</tr>
</tbody>
</table>

Note: Step2 and Step3 can be interchanged.

Usecase-2: Using Filters

Goal: To collect gigabit ethernet interface statistics (using filters)
### Procedure | Example
--- | ---
Step1: Identifying the inputs and other parameters | MIB Objects of interest:
- 1.3.6.1.2.1.2.1.2.1.2 (ifDescr)
- 1.3.6.1.2.1.2.1.2.1.10 (ifInOctets)
- 1.3.6.1.2.1.2.1.2.1.16 (ifOutOctets)
Export Parameters:
- Interval: 60 seconds
- Protocol: TFTP
- Server: 10.105.33.135
- Path: dcm_data

Step2: Configuring the **Data set if-mib**
For detailed procedure:
**Configuring an SNMP Bulkstat Data Set, on page 351**

Step3: Configuring the **Instance set if-mib**
For detailed procedure:
**Configuring an SNMP Bulkstat Instance Set, on page 353**

Step4: Configuring the **Filter set if-mib**
For detailed procedure:
**Configuring an SNMP Bulkstat Filter Set, on page 352**

Step5: Configuring **Data Group if-group**
For detailed procedure:
**Configuring a Bulkstat Data Group, on page 354**

Step6: Configuring **Profile snmp_profile**
For detailed procedure:
**Configuring a Bulkstat Profile, on page 355**

---

**Note**

Step2, Step3 and Step4 can interchanged.
**Usecase-3: Collecting CLI output in XML format**

Goal: To collect show cli output in XML format

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Example</th>
</tr>
</thead>
</table>
| Step 1: Identifying the inputs and other parameters | CLI of interest: `add cmd show operational AAA xml`
| | Export Parameters: |
| | • Interval: 5 minutes |
| | • Protocol: TFTP |
| | • Server: 10.64.68.12 |
| | • Path: dcm_data |
| Step 2: Configuring the **Data set process** | `bulkstat data process type command add cmd show operational AAA xml` |
| For detailed procedure: | **Configuring an SNMP Bulkstat Data Set, on page 351** |
| Step 3: Configuring **Data Group cli-group** | `bulkstat data-group cli-group interval polling 60 collect type command data sh snmp` |
| For detailed procedure: | **Configuring a Bulkstat Data Group, on page 354** |
| Step 4: Configuring **Profile cli_profile** | `bulkstat profile cli_profile file transfer url primary tftp://10.64.68.12/dcm_data/ interval transfer raw 300 data-group cli-group enable` |
| For detailed procedure: | **Configuring a Bulkstat Profile, on page 355** |
Software Entitlement

Cisco IOS XR software contains all the supported features for a given release. Before the introduction of software entitlement on Cisco IOS XR software, you could freely activate all available software packages on your network devices and could enable all the bundled features. Software entitlement has been introduced so you pay only for the features that you need today, but can upgrade when necessary while keeping your investment safe. Licensing enables you to purchase individual software features and upgrade hardware capacity in a safe and reliable way.

The licensing methods supported on Cisco IOS XR software are:

- Smart Licensing
- Default (traditional) Licensing

To locate documentation for other commands that might appear in the course of performing a configuration task, search online in Cisco ASR 9000 Series Aggregation Services Router Commands Master List.

Table 43: Feature History for Software Entitlement

<table>
<thead>
<tr>
<th>Release</th>
<th>Modification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Release 3.9.0</td>
<td>The software entitlement feature was introduced.</td>
</tr>
<tr>
<td>Release 4.3.1</td>
<td>NV Satellite license was supported.</td>
</tr>
<tr>
<td>Release 5.2.0</td>
<td>Smart Licensing was introduced.</td>
</tr>
<tr>
<td>Release 5.3.1</td>
<td>Support for Smart Licensing was introduced on Cisco ASR 9000 High Density 100GE Ethernet line cards. General availability release for Smart Licensing on ASR 9000.</td>
</tr>
<tr>
<td>Release 6.0.1</td>
<td>Updated consumption model line card support</td>
</tr>
</tbody>
</table>

This model contains the following topics:

- What Is Software Entitlement?, on page 362
- Implementing Smart Licensing, on page 363
- Consumption Model, on page 376
- Implementing Default Licensing, on page 381
What Is Software Entitlement?

Software entitlement is a system that consists of a license manager on a Cisco IOS XR device that manages licenses for various software and hardware features. The license manager parses and authenticates a license before accepting it. The software features on the router use the license manager APIs to check out and release licenses. Licenses are stored in persistent storage on the router.

Core routing features are available for use without any license. The following features can be enabled on your router using licenses:

Layer 3 VPN

Layer 3 (virtual private network) VPN can be configured only if there is an available Layer 3 VPN license for the line card slot on which the feature is being configured. If the advanced IP license is enabled, 4096 Layer 3 VPN routing and forwarding instances (VRFs) can be configured on a line card. If the infrastructure VRF license is enabled, eight Layer 3 VRFs can be configured on the line card.

To activate the Infrastructure VRF license, you need to configure two interfaces or sub-interfaces in separate VRFs, with at least one physical interface in each of the VRFs.

The key is to have multiple (two or more) user-defined VRFs configured in at least one slot and at least one physical interface in each user-defined VRF; and repeated for each slot.

In a non-consumption model line card, configuring a physical interface in multiple VRFs would consume a L3VPN license. However, configuring other virtual interfaces (such as management, bundle, or BVI interfaces) in multiple VRFs would not consume L3VPN license.

See the following modules in MPLS Configuration Guide for Cisco ASR 9000 Series Routers for information about Layer 3 VPN configurations:

- Implementing MPLS Layer 3 VPNs on the Cisco ASR 9000 Series Router
- Implementing Virtual Private LAN Services on the Cisco ASR 9000 Series Router

G.709

If a G.709 license is available, G.709 can be enabled on 10-Gigabit Ethernet interfaces on the following line cards:

- 2-port 10 Gigabit Ethernet / 20-port Gigabit Ethernet line card
- 8-port 10 Gigabit Ethernet line card
- 24-port 10 Gigabit Ethernet line card
- 36-port 10 Gigabit Ethernet line card
- 4-port 10 Gigabit Ethernet modular port adapter
- 2-port 10 Gigabit Ethernet modular port adapter

Refer to the Configuring Dense Wavelength Division Multiplexing Controllers on the Cisco ASR 9000 Series Router module in Interface and Hardware Component Configuration Guide for Cisco ASR 9000 Series Routers.

Video Monitoring

Video monitoring can be enabled for the Cisco ASR 9000 chassis by using a video monitoring license.
Satellite Network Virtualization (nV)

The Satellite nV license entitles satellite devices to connect to the Cisco ASR 9000 chassis. Satellite licenses are chassis licenses, and can provide the ability for one, five or 20 satellites to connect to a Cisco ASR 9000 host remotely.

Note

Smart Licensing is supported on a cluster set-up. There are two A9K-NV-CLUSTR-LIC licenses required/requested, one for each of the chassis.

Implementing Smart Licensing

Information About Smart Licensing

Smart Licensing is a cloud-based, software license management solution that enables you to automate time-consuming, manual licensing tasks. The solution allows you to easily track the status of your license and software usage trends.

Smart Licensing helps simplify three core functions:

- **Purchasing**: The software that you have installed in your network can automatically self-register themselves, without Product Activation Keys (PAKs).
- **Management**: You can automatically track activations against your license entitlements. Additionally, there is no need to install the license file on every node. You can create license pools (logical grouping of licenses) to reflect your organization structure. Smart Licensing offers you Cisco Smart Software Manager, a centralized portal that enables you to manage all your Cisco software licenses from one centralized website. *Cisco Smart Software Manager Overview*, on page 374 provides details.
- **Reporting**: Through the portal, Smart Licensing offers an integrated view of the licenses you have purchased and what has been actually deployed in your network. You can use this data to make better purchase decisions, based on your consumption.

Smart Versus Traditional Licensing

<table>
<thead>
<tr>
<th>Traditional (node locked) licencing</th>
<th>Smart (dynamic) licencing</th>
</tr>
</thead>
<tbody>
<tr>
<td>You must procure the license and manually install it on the device.</td>
<td>Your device initiates a call home and requests the licenses it needs. <em>Configuring Call Home on the Cisco ASR 9000 Series Router</em> describes the Smart Call Home feature.</td>
</tr>
<tr>
<td>Node-locked licences - license is associated with a specific device.</td>
<td>Pooled licences - licences are company account-specific, and can be used with any compatible device in your company. You can activate or deactivate different types of licenses on the device without actually installing a license file on the device.</td>
</tr>
<tr>
<td>No common install base location to view licenses purchased or software usage trends</td>
<td>Licenses are stored securely on Cisco servers accessible 24x7x365.</td>
</tr>
</tbody>
</table>
Licenses can be moved between product instances without a license transfer. This greatly simplifies the reassignment of a software license as part of the Return Material Authorization (RMA) process.

Limited visibility into all software licenses being used in the network. Licenses are tracked only on per node basis.

Complete view of all Smart Software Licenses used in the network using a consolidated usage report of software licenses and devices in one easy-to-use portal.

Traditional Licensing Consideration in Smart Licensing, on page 376 describes the scenarios in which you may want to retain the default mode of licensing. It also explains what happens to your traditional license files if you choose to switch to Smart Licensing.

**Smart Licensing in Cisco IOS XR 64 bit**

Smart Licensing is enabled by default on Cisco IOS XR 64 bit. Here are few things to consider for Smart Licensing in Cisco IOS XR 64 bit:

- Smart Licensing cannot be disabled.
- All the Smart Licensing CLIs are executed from EXEC mode.
- EVAL Period is not supported. Hence licenses are consumed only after registration.
- Smart Licensing is supported on A9K-8X100GE-CM, A99-8X100GE-CM, A99-12PT-CM-LIC, and A9K-MOD400-CM-LIC line cards.

This table lists supported licenses for non-CM line cards:

**Table 44: Non-CM Line Cards Software Licenses for Cisco IOS XR 64 bit**

<table>
<thead>
<tr>
<th>Non-CM Line Cards Software License PID</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A9K-800G-IVRF</td>
<td>ASR 9000 8-port 100 GE Infrastructure VRF Right to Use License</td>
</tr>
<tr>
<td>A9K-400G-IVRF</td>
<td>ASR 9000 4-port 100 GE Infrastructure VRF license Right to Use License</td>
</tr>
<tr>
<td>A99-1200G-IVRF</td>
<td>ASR 9900 Infrastructure VRF license Right to Use License</td>
</tr>
<tr>
<td>A9K-800G-AIP-SE</td>
<td>ASR 9000 8-port 100 GE Advance IP Service Edge Right to Use License</td>
</tr>
<tr>
<td>A9K-800G-AIP-TR</td>
<td>ASR 9000 8-port 100 GE Advance IP Transport Optimised Right to Use License</td>
</tr>
<tr>
<td>A9K-400G-AIP-SE</td>
<td>ASR 9000 4-port 100 GE Advance IP Service Edge Right to Use License</td>
</tr>
<tr>
<td>A9K-400G-AIP-TR</td>
<td>ASR 9000 4-port 100 GE Advance IP Transport Optimised Right to Use License</td>
</tr>
<tr>
<td>A99-1200G-AIP</td>
<td>ASR 9900 12port 100GE Advanced IP Right to Use License</td>
</tr>
</tbody>
</table>
Non-CM Line Cards Software License PID | Description
---|---
A9K-800G-OPT-LIC | ASR 9000 8-port 100 GE Advance Optical Right to Use License
A9K-400G-OPT-LIC | ASR 9000 4-port 100 GE Advance Optical Right to Use License
A99-1200G-ADVRTNG | ASR 9900 12port 100GE Advanced Routng Right to Use License

This is the list of show commands available for Smart Licensing in Cisco IOS XR 64 bit:

- show license all—shows all information regarding Smart license
- show license platform—shows platform-specific licensing information (cisco-support)
- show license status—shows smart licensing status information
- show license summary—shows smart licensing summary
- show license techsupport—shows smart licensing tech support information
- show license trace—shows tracing for smart licensing code (cisco-support)
- show license udi—shows smart licensing UDI information
- show license usage—shows smart licensing usage information
- show license platform detail—shows smart license detail information (cisco-support)
- show license platform summary—shows smart license summary (cisco-support)
- show license platform trace—shows platform specific licensing trace information (cisco-support)

Create a Cisco Smart Account

Cisco Smart Account is an account where all products enabled for Smart Licensing are deposited. Cisco Smart Account allows you to manage and activate your licenses to devices, monitor license use, and track Cisco license purchases. Through transparent access, you have a real-time view into your Smart Licensing products. IT administrators can manage licenses and account users within your organization's Smart Account through the Smart Software Manager.

You can create your Cisco Smart Account at this webpage: [https://webapps.cisco.com/software/company/smartaccounts/home/#accountcreation-account/request](https://webapps.cisco.com/software/company/smartaccounts/home/#accountcreation-account/request).


Smart Licensing Working

Smart Licensing involves the three steps shown in the illustration below, that depicts the working model of the Smart Licensing.
• **Setting up Smart Licensing:** You can place the order for Smart Licensing, to manage licenses on Cisco.com portal. You agree to the terms and conditions governing the use and access of Smart Licensing in the Smart Software Manager portal at http://www.cisco.com/c/en/us/products/collateral/software/one-software/solution-overview-c22-733273.html.

• **Enabling and Use Smart Licensing:** Follow the steps to enable Smart Licensing. *Smart Licensing Workflow* provides an illustration.

After you enable Smart Licensing, you can use either of the following options to communicate:

• **Smart Call Home:** The Smart Call Home feature is automatically configured after the Smart Licensing is enabled. Smart Call Home is used by Smart Licensing as a medium for communication with the Cisco license service. Call Home feature allows Cisco products to periodically call-home and perform an audit and reconciliation of your software usage information. This information helps Cisco efficiently track your install base, keep them up and running, and more effectively pursue service and support contract renewals, without much intervention from your end. For more information on Smart Call Home feature, see http://www.cisco.com/c/dam/en/us/td/docs/switches/lan/smart_call_home/SCH_Deployment_Guide.pdf.

• **Smart Licensing Satellite:** The Smart licensing satellite option provides an on-premises collector that can be used to consolidate and manage Smart license usage, as well facilitate communications back to Cisco License Service at http://www.cisco.com.
Manage and Report Licenses: You can manage and view reports about your overall software usage in the Smart Software Manager portal. Compliance reporting, on page 375 describes the types of Smart Licensing reports.

Deployment Options for Smart Licensing

The following illustration shows the various options available for deploying Smart Licensing:

Figure 11: Smart Licensing Deployment Options

1. Direct cloud access: In direct cloud access deployment method, Cisco products send usage information directly over the internet to Cisco.com (Cisco license service); 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 Cisco License Service 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.
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 (maybe once a month) to keep the databases in synchronization.

Options 1 and 2 provide an easy deployment option, and options 3 and 4 provide a secure environment deployment option. Smart Software Satellite provides support for options 3 and 4.

The communication between Cisco products and Cisco license service is facilitated by the Smart Call Home software. For information on Smart Call Home, see About Call Home, on page 321

**Configure Licenses Using Smart Licensing**

**Enable Smart Licensing**

Smart Licensing components are packaged into the asr9k mini image. The https client required for configuring the Smart Call Home is packaged into the asr9k-k9sec PIE. By default, traditional licensing mode is on. Use the steps described here to enable Smart Licensing.

---

**Note**

Smart Licensing on Cisco ASR 9001-S Router is not supported. Hence you should use the Product Authorization Key (PAK) to activate a license. PAK is provided when you order and purchase the right to use a feature set for a particular device. The PAK is an 11-character alphanumeric key printed on the purchase order document that is shipped with your device hardware. The PAK serves as a receipt and is an important component used in the process of obtaining, upgrading, and activating a license.

For information on how to activate a license using PAK, refer Cisco ASR 9001-S 120G Upgrade License Configuration Guide.

On successful registration, the device will receive an identity certificate. This certificate is saved on your device and automatically used for all future communications with Cisco. Every 30 days, Smart Licensing will automatically renew the registration information with Cisco. If registration fails, an error will be logged. Additionally, license usage data is collected and a report is sent to you every month. If required, you can configure your Smart Call Home settings such that sensitive information (like hostname, username and password) are filtered out from the usage report.

---

**Note**

Once Smart Licensing mode is enabled, all CLIs related to the traditional licensing mode are disabled.

---

**Before you begin**

You must have purchased the product for which you are adding the license. When you purchase the product, you are provided with a user name and password to the Cisco Smart Software Manager portal, from where you can generate the product instance registration tokens.

**SUMMARY STEPS**

1. Login to Cisco Smart Software Manager at [https://tools.cisco.com/rhodui/index](https://tools.cisco.com/rhodui/index).
2. admin
3. configure
4. license smart enable
5. commit
6. admin
7. license smart register idtoken \textit{token} \_ID

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td>Login to Cisco Smart Software Manager at <a href="https://tools.cisco.com/rhodui/index">https://tools.cisco.com/rhodui/index</a>. Get a token from the Cisco portal using the link. You must log in to the portal using a Cisco provided username and password. Once you have generated the token, select \textbf{Copy} hyperlink to copy the token or download the token to a text file. The token is used to register and activate a device, and assign the device to a virtual account. \textbf{Note} This token is valid for 30 days.</td>
</tr>
<tr>
<td><strong>Step 2</strong></td>
<td>admin \textbf{Example:} \textbf{RP/0/RSP0/CPU0:router}# admin Enters administration EXEC mode.</td>
</tr>
<tr>
<td><strong>Step 3</strong></td>
<td>configure \textbf{Example:} \textbf{RP/0/RSP0/CPU0:router}# admin(config)# configure Enter administration configuration mode.</td>
</tr>
<tr>
<td><strong>Step 4</strong></td>
<td>license smart enable \textbf{Example:} \textbf{RP/0/RSP0/CPU0:router}# admin(config)# license smart enable \textbf{RP/0/RSP0/CPU0:router}# show config Building configuration... !! IOS XR Configuration 5.2.0.19I license smart enable end Enables basic Smart Licensing. Use the \textbf{no} form of this command to disable Smart Licensing and revert to the traditional or strict mode of licensing.</td>
</tr>
<tr>
<td><strong>Step 5</strong></td>
<td>commit</td>
</tr>
<tr>
<td><strong>Step 6</strong></td>
<td>admin \textbf{Example:} \textbf{RP/0/RSP0/CPU0:router}# admin Enters administration EXEC mode.</td>
</tr>
<tr>
<td><strong>Step 7</strong></td>
<td>license smart register idtoken \textit{token} _ID \textbf{Example:} \textbf{RP/0/RSP0/CPU0:router}# admin(config)# license smart register idtoken NmE1Yzg0OWMtYmJ4 Use the token ID procured in step 1 to register your device.</td>
</tr>
</tbody>
</table>
Purpose

Command or Action | Purpose
---|---
license smart register: Registration process is in progress. Please check the syslog for the registration status and result | 

What to do next

You can use the Cisco Smart Software Manager to:

- Create virtual accounts
- Assign a registered device to a virtual account
- View licenses in a virtual account
- Manage product instance registration tokens
- Transfer a license
- View, transfer or remove product instances in a virtual account

Verify Smart Licensing Configuration

After enabling Smart Licensing, you can use the `show` commands to verify the default Smart Licensing configuration. If any issue is detected, take corrective action before making further configurations.

SUMMARY STEPS

1. admin
2. show license status
3. show license register-status
4. show license entitlement
5. show license pool
6. show license cert
7. show license features
8. show license ha
9. show license all
10. exit
11. show call-home smart-licensing statistics

DETAILED STEPS

<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1</td>
<td>admin</td>
<td>Enters administration EXEC mode.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>RP/0/RSP0/CP00:router# admin</td>
<td></td>
</tr>
<tr>
<td>Step 2</td>
<td>show license status</td>
<td>Displays the compliance status of Smart Licensing. Following are the possible status:</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
<td>- <strong>Waiting</strong>: Indicates the initial state after your device has made a license entitlement request. The device establishes communication with Cisco and</td>
</tr>
<tr>
<td></td>
<td>RP/0/RSP0/CP00:router(admin)# show license status</td>
<td></td>
</tr>
<tr>
<td>Command or Action</td>
<td>Purpose</td>
<td></td>
</tr>
<tr>
<td>-------------------</td>
<td>---------</td>
<td></td>
</tr>
<tr>
<td><strong>Successfully registers itself with the Cisco license manager.</strong>&lt;br&gt;• <strong>Authorized</strong>: Indicates that your device is able to communicate with the Cisco license manager, and is authorised to initiate requests for license entitlements.&lt;br&gt;• <strong>Out-Of-Compliance</strong>: Indicates that one or more of your licenses are out-of-compliance. You must buy additional licenses.&lt;br&gt;• <strong>Eval Period</strong>: Indicates that Smart Licencing is consuming the evaluation period. You must register the device with the Cisco Licensing manager, else your license expires.&lt;br&gt;• <strong>Grace Period</strong>: Indicates that connectivity to the Cisco license manager is lost. You must try restore connectivity to renew the authorization period.&lt;br&gt;• <strong>Disabled</strong>: Indicates that Smart Licensing is disabled.&lt;br&gt;• <strong>Invalid</strong>: Indicates that Cisco does not recognize the entitlement tag as it is not in the database.</td>
<td>Displays the Smart Licensing registration status. If your registration is pending or failed, check for connectivity issues with the Cisco license manager or register the device with a new token ID.</td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong>&lt;br&gt;<strong>show license register-status</strong>&lt;br&gt;<strong>Example:</strong>&lt;br&gt;RP/0/RSP0/CPU0:router(admin)#show license register-status</td>
<td>Displays the Smart Licensing registration status. If your registration is pending or failed, check for connectivity issues with the Cisco license manager or register the device with a new token ID.</td>
<td></td>
</tr>
<tr>
<td><strong>Step 4</strong>&lt;br&gt;<strong>show license entitlement</strong>&lt;br&gt;<strong>Example:</strong>&lt;br&gt;RP/0/RSP0/CPU0:router(admin)#show license entitlement</td>
<td>Displays the details of the various entitlements you own.</td>
<td></td>
</tr>
<tr>
<td><strong>Step 5</strong>&lt;br&gt;<strong>show license pool</strong>&lt;br&gt;<strong>Example:</strong>&lt;br&gt;RP/0/RSP0/CPU0:router(admin)#show license pool</td>
<td>Displays the pool to which the device belongs.</td>
<td></td>
</tr>
<tr>
<td><strong>Step 6</strong>&lt;br&gt;<strong>show license cert</strong>&lt;br&gt;<strong>Example:</strong>&lt;br&gt;RP/0/RSP0/CPU0:router(admin)#show license cert</td>
<td>Displays details of the licensing certificate.</td>
<td></td>
</tr>
<tr>
<td><strong>Step 7</strong>&lt;br&gt;<strong>show license features</strong>&lt;br&gt;<strong>Example:</strong>&lt;br&gt;RP/0/RSP0/CPU0:router(admin)#show license features</td>
<td>Displays the licenses that are supported on a given chassis. You can go ahead and buy the required licenses.</td>
<td></td>
</tr>
<tr>
<td><strong>Step 8</strong>&lt;br&gt;<strong>show license ha</strong>&lt;br&gt;<strong>Example:</strong>&lt;br&gt;RP/0/RSP0/CPU0:router(admin)#show license ha</td>
<td>Displays the Smart Licensing high availability status, whether it is in active or standby mode.</td>
<td></td>
</tr>
</tbody>
</table>
### Command or Action

<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 9</td>
<td>show license all</td>
<td>Displays all entitlements in use. It can also be used to check if Smart Licensing is enabled. Additionally, it shows associated licensing certificates, compliance status, UDI, and other details.</td>
</tr>
<tr>
<td>Example:</td>
<td>RP/0/RSP0/CP0:router(admin)#show license all</td>
<td></td>
</tr>
<tr>
<td>Step 10</td>
<td>exit</td>
<td>Exits administration EXEC mode and returns to EXEC mode.</td>
</tr>
<tr>
<td>Example:</td>
<td>RP/0/RSP0/CP0:router(admin)# exit</td>
<td></td>
</tr>
<tr>
<td>Step 11</td>
<td>show call-home smart-licensing statistics</td>
<td>Displays the statistics of communication between the Smart Licensing manager and the Cisco back-end using Smart Call Home. In case communication fails or drops, check your call home configuration for any errors.</td>
</tr>
</tbody>
</table>

The following example shows sample output from the `show call-home smart-licensing statistics` command:

```
RP/0/RSP0/CP0:router#show call-home smart-licensing statistics
Success: Successfully sent and response received.
Failed : Failed to send or response indicated error occurred.
Inqueue: In queue waiting to be sent.
Dropped: Dropped due to incorrect call-home configuration.

<table>
<thead>
<tr>
<th>Msg Subtype</th>
<th>Success</th>
<th>Failed</th>
<th>Inqueue</th>
<th>Dropped</th>
<th>Last-sent (GMT-07:00)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENTITLEMENT</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2014-04-24 18:24:34</td>
</tr>
<tr>
<td>REGISTRATION</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2014-04-25 03:53:57</td>
</tr>
<tr>
<td>ACKNOWLEDGEMENT</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2014-04-23 19:21:21</td>
</tr>
<tr>
<td>RENEW</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2014-04-23 19:21:11</td>
</tr>
<tr>
<td>DEREGISTRATION</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2014-04-25 03:31:35</td>
</tr>
</tbody>
</table>
```

### Renew Smart Licensing Registration

In general, your registration is automatically renewed every 30 days. Use this option to make an on-demand manual update of your registration. Thus, instead of waiting 30 days for the next registration renewal cycle, you can issue this command to instantly find out the status of your license.

**Before you begin**

You must ensure that the following conditions are met to renew your smart license:

- Smart licensing is enabled.
- The device is registered.

**SUMMARY STEPS**

1. `admin`
2. `license smart renew {auth | id}`
DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> admin</td>
<td>Enters administration EXEC mode.</td>
</tr>
<tr>
<td>Example: RP/0/RSP0/CPU0:router# admin</td>
<td></td>
</tr>
<tr>
<td><strong>Step 2</strong> license smart renew {auth</td>
<td>id}</td>
</tr>
<tr>
<td>Example: RP/0/RSP0/CPU0:ROA(admin)#license smart renew auth</td>
<td></td>
</tr>
<tr>
<td>Tue Apr 22 09:12:37.086 PST</td>
<td></td>
</tr>
<tr>
<td>license smart renew auth: Authorization process is in progress. Please check the syslog for the authorization status and result.</td>
<td></td>
</tr>
</tbody>
</table>

De-register Smart Licensing

When your device is taken off the inventory, shipped elsewhere for redeployment or returned to Cisco for replacement using the return merchandise authorization (RMA) process, you can use the de-register option to cancel the registration on your device. Use the following steps to cancel device registration:

SUMMARY STEPS

1. admin
2. license smart deregister

DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> admin</td>
<td>Enters administration EXEC mode.</td>
</tr>
<tr>
<td>Example: RP/0/RSP0/CPU0:router# admin</td>
<td></td>
</tr>
<tr>
<td><strong>Step 2</strong> license smart deregister</td>
<td>Cancels the device registration, and sends it into a 30-day evaluation mode. All Smart Licensing entitlements and certificates on the platform are removed.</td>
</tr>
<tr>
<td>Example: RP/0/RSP0/CPU0:IMC0(admin)#license smart deregister</td>
<td></td>
</tr>
<tr>
<td>license smart deregister: Success</td>
<td></td>
</tr>
</tbody>
</table>

Note: Authorization periods are renewed by the Smart Licensing system every 30 days. As long as the license is in an 'Authorized' or 'Out-of-compliance' (OOC), 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 renew the authorization period. If a retry is successful, a new authorization period starts.

De-register Smart Licensing: Success

Though the product instance has been de-registered from the Cisco license cloud service, Smart Licencing is still enabled.
Smart Licensing Workflow

The Smart Licensing workflow is depicted in this flowchart.

Cisco Smart Software Manager Overview

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). Use the Cisco Smart Software Manager to do the following tasks:

- 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.

The Cisco Smart Software Manager Help describes the procedures for carrying out these tasks. You can access the Cisco Smart Software Manager on https://webapps.cisco.com/software/csws/ws/platform/home, by clicking Licensing, and then selecting Smart Software Manager; and then login using the username and password provided by Cisco.

Note

Use Chrome 32.0, Firefox 25.0 or Safari 6.0.5 web browsers to access the Cisco Smart Software Manager. Also, ensure that Javascript 1.5 or a later version is enabled in your browser.

Licenses, Product Instances, and Registration Tokens

Licenses

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>License command &quot;license smart deregister &quot; completed successfully.</td>
<td></td>
</tr>
</tbody>
</table>
Licenses are required for all Cisco products. All Cisco product licenses are one of two types which vary depending on the product:

- **Perpetual licenses**—Licenses that do not expire.
- **Term licenses**—Licenses that automatically expire after a set amount of time: one year, three years, or whatever term was purchased.

In addition, there are demo licenses that expire after at most 60 days. As implied by the name, demo licenses are not intended for production use.

All product licenses reside in a virtual account.

**Product Instances**

A product instance is an individual device with a unique device identifier (UDI) that is registered using a product instance registration token (or registration token). You can register any number of instances of a product with a single registration token. Each product instance can have one or more licenses residing in the same virtual account. Product instances must periodically connect to the Cisco Smart Software Manager servers during a specific renewal period. If a product instance fails to connect, it is marked as having a license shortage, but continues to use the license. If you remove the product instance, its licenses are released and made available within the virtual account.

**Product Instance Registration Tokens**

A product requires a registration token until you have registered the product. Registration tokens are stored in the Product Instance Registration Token Table associated with your enterprise account. Once the product is registered the registration token is no longer necessary and can be revoked and removed from the table without effect. Registration tokens can be valid from 1 to 365 days.

**Virtual Accounts**

Smart Licencing allows you to create multiple license pools or virtual accounts within the Smart Software Manager portal. Using the **Virtual Accounts** option you can aggregate licenses into discrete bundles associated with a cost center so that one section of an organization cannot use the licenses of another section of the organization. For example, if you segregate your company into different geographic regions, you can create a virtual account for each region to hold the licenses and product instances for that region.

All new licenses and product instances are placed in the default virtual account in the Smart Software Manager, unless you specify a different one during the order process. Once in the default account, you may choose to transfer them to any other account as desired, provided you have the required access permissions. See Licenses, Product Instances, and Registration Tokens, on page 374 for details.

Use the Smart Software Manager portal at https://tools.cisco.com/rhodui/index to create license pools or transfer licenses.

**Compliance reporting**

On a periodic basis, as described by the terms of the Smart Licensing contract, reports are automatically sent to you containing inventory and license compliance data. These reports will take one of three forms:

- **Periodic Record**: This record is generated on a periodic (configurable) basis with relevant inventory data saved at a given point of time. This report is saved within the Cisco cloud for archival.

- **Manual Record**: You can manually generate this record with relevant inventory data saved at any given point of time. This report will be saved within the Cisco cloud for archival.
Compliance Warning Report: This report is automatically or manually generated when a license compliance event occurs. This report does not contain a full inventory data, but only any shortfalls in entitlements for a given software license.

You can view these reports from the Smart Software Manager portal at https://tools.cisco.com/rhodui/index.

Traditional Licensing Consideration in Smart Licensing

Traditional licensing, and the associated commands, currently co-exist with Smart Licensing. By default, the software image is loaded with the traditional, strictly-enforced mode of licensing. You may want to retain the traditional licensing model in the following scenarios:

- when there are multiple users, and you do not know the actual end user of your software.
- when the software is deployed in a location with limited access to the license and inventory management solution.
- when the user has opted not to establish a Smart Call Home relationship with Cisco.
- when a Smart Call Home relationship cannot be maintained with the user owing to logistics and a fallback is required.

Note

All traditional licencing CLI commands are disabled if Smart Licensing is enabled. However, you can continue to access the traditional licenses stored under: /disk0:/license/*. Certificates used by Smart Licencing are located under /disk0:/sla/*. Respective CLIs are restored when licensing schemes are switched.

Consumption Model

The consumption model is a new pricing model for line cards to align the initial purchase to your actual needs. This model provides the ability to deploy a line card on day 1 with minimum ports activated to meet the current traffic demands. Over time as the traffic grows, you can add additional ports in 10G port increments. This provides a flexible deployment model with the ability to increase bandwidth to meet your demands.

Figure 12: Comparison - Current Purchasing Model And The New Consumption Model
The consumption model line cards require the users to deploy Smart Licensing to help track and provide visibility into license usage across their network. For information on Smart Licensing see Information About Smart Licensing, on page 363.

You must have a Smart Account created to place an order for the consumption model line card. You can create your Cisco Smart Account at this webpage: https://webapps.cisco.com/software/company/smartaccounts/home#accountcreation-account/request. For information on how to create a Cisco Smart Account, see: http://www.cisco.com/c/en/us/products/collateral/software/one-software/solution-overview-c22-733273.html.

**Supported Consumption Model Line Cards**

The line cards that can be deployed using consumption model are referred to as the consumption model line cards. The supported consumption model line cards are:

- A9K-8X100GE-CM
- A99-8X100GE-CM
- A99-12X100GE-CM
- A9K-MOD400-CM

**Ordering the Consumption Model Line Card using the Consumption Model**

The three steps involved in ordering a consumption model line card using the Consumption Model are:

*Figure 13: Steps involved in ordering the consumption model line card using the Consumption Model*
1. Choose the hardware: Select a line card that supports Consumption Model. The consumption model line cards require Smart Licensing to be installed at your location to function. When placing an order, you must enter their Smart Account information. For more information on how to create a Cisco Smart Account, see: [http://www.cisco.com/c/en/us/products/collateral/software/one-software/solution-overview-c22-733273.html](http://www.cisco.com/c/en/us/products/collateral/software/one-software/solution-overview-c22-733273.html).

<table>
<thead>
<tr>
<th>Minimum Foundation Software License Required</th>
</tr>
</thead>
<tbody>
<tr>
<td>PID</td>
</tr>
<tr>
<td>A9K-8X100GE-CM</td>
</tr>
<tr>
<td>A99-8X100GE-CM</td>
</tr>
<tr>
<td>A99-12X100GE-CM</td>
</tr>
<tr>
<td>A9K-MOD400-CM-BUN</td>
</tr>
</tbody>
</table>

2. Choose your foundation software licenses: This provides the transport protocol (IP/MPLS, L2VPN, L3VPN, or L2VPN and L3VPN) as well as "per 10G" port activation.

Pick your foundation software licenses based on the feature set and the scale required. The following is the list of the available licenses. The licenses listed are per 10G RTU (Right to Use) and are required to activate a port.

<table>
<thead>
<tr>
<th>Foundation License PID</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>S-A9K-IPB-10G</td>
<td>ASR 9000 IP/MPLS Basic 10G Foundational License</td>
</tr>
<tr>
<td>S-A9K-IPP-10G</td>
<td>ASR 9000 IP/MPLS Premium 10G Foundational License</td>
</tr>
<tr>
<td>S-A9K-L2B-10G</td>
<td>ASR 9000 IP/MPLS/L2VPN Basic 10G Foundational License</td>
</tr>
<tr>
<td>S-A9K-L2P-10G</td>
<td>ASR 9000 IP/MPLS/L2VPN Premium 10G Foundational License</td>
</tr>
<tr>
<td>S-A9K-L3B-10G</td>
<td>ASR 9000 IP/MPLS/L3VPN Basic 10G Foundational License</td>
</tr>
<tr>
<td>S-A9K-L3P-10G</td>
<td>ASR 9000 IP/MPLS/L3VPN Premium 10G Foundational License</td>
</tr>
<tr>
<td>S-A9K-L2L3B-10G</td>
<td>ASR 9000 IP/MPLS/L2VPN/L3VPN Basic 10G Foundational License</td>
</tr>
</tbody>
</table>
3. Choose your advanced software licenses: This provides the advanced feature support such as hierarchical QoS, OAM (Operations, Administration, and Maintenance), and virtual interfaces.

Pick your advanced software licenses, optional, you can select one or more of them from the following list. The licenses listed are per 10G RTU (Right to Use).

Below tables list supported advance software licenses for Cisco IOS XR and Cisco IOS XR 64 bit respectively:

**Table 47: Advanced Software Licenses for Cisco IOS XR**

<table>
<thead>
<tr>
<th>Advanced Software License PID</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>S-A9K-HQOS-RTU-10</td>
<td>ASR 9000 H-QoS 10G Right to Use License</td>
</tr>
<tr>
<td>S-A9K-MAP-RTU-10</td>
<td>ASR 9000 CGN Stateless MAP 10G Right to Use License</td>
</tr>
<tr>
<td>S-A9K-OAM-RTU-10</td>
<td>ASR 9000 OAM 10G Right to Use License</td>
</tr>
<tr>
<td>S-A9K-VIRT-RTU-10</td>
<td>ASR 9000 Virtual Interfaces 10G Right to Use License</td>
</tr>
<tr>
<td>S-A9K-EVPN-RTU-10</td>
<td>ASR 9000 E-VPN 10G Right to Use License</td>
</tr>
<tr>
<td>S-A9K-VXLN-RTU-10</td>
<td>ASR 9000 VxLAN 10G Right to Use License</td>
</tr>
<tr>
<td>S-A9K-DWDM-RTU-10</td>
<td>ASR 9000 IPoDWDM 10G Right to Use License</td>
</tr>
<tr>
<td>S-A9K-MAC-RTU-10</td>
<td>ASR 9000 MACSec 10G Right to Use License</td>
</tr>
<tr>
<td>S-A9K-MAC-RTU-40</td>
<td>ASR 9000 MACSec 40G (4x10G) Right to Use License</td>
</tr>
<tr>
<td>S-A9K-MAC-RTU-100</td>
<td>ASR 9000 MACSec 100G (10x10G) Right to Use License</td>
</tr>
</tbody>
</table>

**Table 48: Advanced Software Licenses for Cisco IOS XR 64 bit**

<table>
<thead>
<tr>
<th>Advanced Software License PID</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>S-A9K-HQOS-RTU-10</td>
<td>ASR 9000 H-QoS 10G Right to Use License</td>
</tr>
<tr>
<td>S-A9K-OAM-RTU-10</td>
<td>ASR 9000 OAM 10G Right to Use License</td>
</tr>
<tr>
<td>S-A9K-VIRT-RTU-10</td>
<td>ASR 9000 Virtual Interfaces 10G Right to Use License</td>
</tr>
<tr>
<td>S-A9K-EVPN-RTU-10</td>
<td>ASR 9000 E-VPN 10G Right to Use License</td>
</tr>
<tr>
<td>S-A9K-VXLN-RTU-10</td>
<td>ASR 9000 VxLAN 10G Right to Use License</td>
</tr>
<tr>
<td>S-A9K-DWDM-RTU-10</td>
<td>ASR 9000 IPoDWDM 10G Right to Use License</td>
</tr>
<tr>
<td>S-A9K-MAC-RTU-10</td>
<td>ASR 9000 MACSec 10G Right to Use License</td>
</tr>
<tr>
<td>S-A9K-MAC-RTU-100</td>
<td>ASR 9000 MACSec 100G Right to Use License</td>
</tr>
</tbody>
</table>
Configuration Examples:

The Consumption Model line cards provide the flexibility to configure the line card on a per 10G port basis. Here are a few examples of configurations of the existing TR and SE versions of line cards using the Consumption Model.

**TR Equivalent Configuration**

The TR equivalent configuration is a configuration with L2 Premium Foundation Software License plus OAM and Virtual Advanced Software licenses.

<table>
<thead>
<tr>
<th>Line Card PID</th>
<th>Description</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>A9K-8X100GE-CM</td>
<td>ASR 9000 8-port 100GE Consumption Model Line Card</td>
<td>1</td>
</tr>
<tr>
<td>A99-8X100GE-CM</td>
<td>ASR 9000 8-port 100GE Consumption Model Line Card</td>
<td></td>
</tr>
<tr>
<td>A9K-20X10GE-CM</td>
<td>ASR 9000 20-port 10GE Consumption Model Line Card</td>
<td></td>
</tr>
<tr>
<td>A99-12X100GE-CM</td>
<td>ASR 9000 12-port 100GE Consumption Model Line Card</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Foundation Software PID</th>
<th>Scale</th>
<th>Quantity of 10G Licenses</th>
</tr>
</thead>
<tbody>
<tr>
<td>S-A9K-L2P-10G</td>
<td>L2-P (Layer 2 Premium Foundation Software License)</td>
<td>30</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Advanced Software PID</th>
<th>Description</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>S-A9K-OAM-RTU-10</td>
<td>ASR 9000 OAM 10Gbps Right to Use License</td>
<td>30</td>
</tr>
<tr>
<td>S-A9K-VIRT-RTU-10</td>
<td>ASR 9000 Virtual Interfaces 10Gbps Right to Use License</td>
<td>30</td>
</tr>
</tbody>
</table>

**SE Equivalent Configuration**

The SE equivalent configuration is a configuration with L2 Premium Foundation Software License plus H-QoS, OAM, and Virtual Advanced Software licenses.
Implementing Default Licensing

Prerequisites for Configuring Software Entitlement

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 Default (Traditional) Licensing

To configure software license entitlements using the default mode of licensing, you need to understand the concepts described in this module.

Types of Licenses

The following types of licenses are currently defined:

- Permanent licenses—Licenses that enable a designated feature permanently, as long as the license resides on the router.

Router License Pools

License pools are maintained by the router. By default, all added licenses are allocated to the owner secure domain router (SDR) license pool, and they can be freely allocated to any slot in the router. Features on cards belonging to the owner SDR are granted licenses based on availability in the owner SDR license pool.
Chassis-Locked Licenses

Licenses are locked to a unique device identifier (UDI). The UDI is comprised of the chassis serial number, along with an additional identifier. The complete set of UDI information can be displayed using the `show license udi` command. The license manager parses the user-provided license and verifies that it is valid for the chassis it is running on and determines if the license is being readded.

Slot-Based Licenses

Feature licenses are allocated to router slots and not cards. Therefore, if a card is replaced, the existing license is applied to the newly inserted card. For example, if you have eight licenses for Layer 3 VPN in the system, you can configure Layer 3 VPN features on any eight cards in the router, and the licenses are allocated to the slots within which the cards are installed. If a card is removed from one of these licensed slots, say slot 3, and entered into an empty slot with no license, say slot 5, the license remains with slot 3 and the feature cannot be activated on slot 5 with the permanent license entered earlier by the user. In this case, you can release the license to the appropriate license pool by removing the configuration of the card (while it is inserted), or by using the `license move slot` command. When you configure the feature on slot 5, the license is checked out.

Configure Licenses Using Default Licensing

Adding a License for a New Feature

This task describes how to acquire a permanent license for a feature that you have purchased or an evaluation license for a feature that you have arranged with your sales representative to try. Use this procedure to replace evaluation licenses with permanent licenses.

Before you begin

You must have purchased the feature for which you are adding the license. When you purchase the feature, you are provided with a product authorization key (PAK) that you use to download the license.

SUMMARY STEPS

1. admin
2. show license udi
4. Copy the license to your TFTP server.
5. admin
6. license add license-name [ sdr sdr-name ]
7. configure
8. license license-name location { all | node-id }
9. exit

DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td><strong>admin</strong>&lt;br&gt;Example:</td>
</tr>
</tbody>
</table>
For adding a license for a new feature:

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>RP/0/RSP0/CPU0:router# admin</td>
<td>Displays the UDI of the chassis. This consists of a product identifier (PID), serial number (S/N), and operation identifier (Operation ID).</td>
</tr>
</tbody>
</table>

**Step 2**

**show license udi**

**Example:**

```
RP/0/RSP0/CPU0:router# show license udi
Mon Jul 13 04:36:32.715 PST
Local Chassis UDI Information:
  PID : ASR-9010-AC
  S/N : FOX1232H67M
  Operation ID: 1
```

**Step 3**

http://www.cisco.com/go/license

Go to the license tool on Cisco.com. You must log in to the site before you can access the license tool. Follow the instructions for product license registration. You are required to enter the feature PAK and the chassis UDI to acquire the license.

**Note** If you are installing a permanent license, you should have received the PAK when you purchased the feature. If you are installing an evaluation license, your sales representative should provide you with the PAK.

**Step 4**

Copy the license to your TFTP server.

You will be issued a license. You can copy the license and store it on your computer, or alternatively, you can request that the license be sent to you in an e-mail. When you have received the license, copy it to a TFTP server that is accessible by your router.

**Step 5**

admin

**Example:**

```
RP/0/RSP0/CPU0:router# admin
```

Enters administration EXEC mode.

**Step 6**

license add license-name [ sdr sdr-name ]

**Example:**

```
RP/0/RSP0/CPU0:router# license add tftp://192.10.10.10/mylicenses/lc40g_lic
```

Adds the license to the SDR license pool. By default, the license is added to the owner SDR license pool.

**Step 7**

configure

**Example:**

```
RP/0/RSP0/CPU0:router# configure
```

Enters administration configuration mode.
### Purpose

Command `license license-name location {all | node-id}`

**Example:**

RP/0/RSP0/CPU0:router(config)# license A9K-ADV-OPTIC-LIC location 0/0/CPU0

(Optional) Binds the license to the slot where it is to be used.

**Note**
Beginning with Cisco IOS XR Release 4.3.1, this command is optional. If you do not use this command, it is configured as though the license is bound to all slots.

### Step 9

**Command or Action** `exit`

**Example:**

RP/0/RSP0/CPU0:router(config)# exit

Exits administration EXEC mode.

### What to do next

To use the feature associated with the added license, you must configure it on your router. To configure Layer 3 VPN, see the Implementing MPLS Layer 3 VPNs on Cisco IOS XR Software module in MPLS Configuration Guide for Cisco ASR 9000 Series Routers.

To verify that your Layer 3 VPN configuration is operational, use the `show rsi interface all global` command.

### Backing Up Licenses

When your router is configured with the licenses that you require, you should perform this task to back up all licenses. Backing up licenses makes it easier to restore them if there is a problem.

**SUMMARY STEPS**

1. `admin`
2. `license backup backup-file`
3. `show license backup backup-file`

**DETAILED STEPS**

**Step 1**

**Command or Action** `admin`

**Example:**

RP/0/RSP0/CPU0:router# admin

Enters administration EXEC mode.

**Step 2**

**Command or Action** `license backup backup-file`

**Example:**

RP/0/RSP0/CPU0:router(config)# license backup disk1:/license_back

License command "license backup disk1:/license_back" completed successfully.

Backs up all licenses on the router to a backup file in the specified location. The backup file can be a local file or a remote file on a TFTP or RCP server.
### Command or Action

<table>
<thead>
<tr>
<th>Step 3</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>show license backup backup-file</td>
<td>Displays the contents of the backup file.</td>
</tr>
</tbody>
</table>

**Example:**

```plaintext
RP/0/RSP0/CPU0:router(admin)# show license backup disk1:/license_back
```

### Examples

The following example shows sample output from the `show license backup` command.

```plaintext
RP/0/RSP0/CPU0:router(admin)# show license backup disk1:/license_back

Local Chassis UDI Information:
  S/N : TBA09370035
  Operation ID: 5
  Licenses :
  FeatureID  Type  #installed
  CRS-MSC-40G  Slot based, Permanent  2
  XC-L3VPN   Slot based, Permanent  1

RP/0/RSP0/CPU0:router(admin)# show license backup disk0:/lic_backup.pkg

Tue Jul 27 17:12:44.982 pst

Local Chassis UDI Information:
  S/N : FOX1316G5TL
  Operation ID: 9
  FeatureID: A9K-ADV-OPTIC-LIC (Slot based, Permanent)
  Total licenses 1
  Pool: Owner 1
  Allocated Node(s):
     0/0/CPU0 1 [Owner]

  FeatureID: A9K-ADV-VIDEO-LIC (Slot based, Evaluation)
  Total licenses 1
  Pool: Owner 1
  Allocated Node(s):
     0/RSP0/CPU0 1 [Owner]

  FeatureID: A9K-iVRF-LIC (Slot based, Permanent)
  Total licenses 1
  Pool: Owner 1

  FeatureID: A9K-iVRF-LIC (Slot based, Evaluation)
  Total licenses 3
  Pool: Owner 3
  Allocated Node(s):
     0/1/CPU0 1 [Owner]
```
Restoring Licenses

If your licenses become corrupted, and you have previously created a backup of your licenses, you can perform this task to restore the licenses to your router.

Before you begin

You must have created a backup file of your licenses before you can restore them on your router.

SUMMARY STEPS

1. admin
2. show license backup backup-file
3. license restore backup-file

DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td><strong>admin</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Example:</strong></td>
</tr>
<tr>
<td></td>
<td>RP/0/RSP0/CPU0:router# admin</td>
</tr>
<tr>
<td><strong>Step 2</strong></td>
<td><strong>show license backup backup-file</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Example:</strong></td>
</tr>
<tr>
<td></td>
<td>RP/0/RSP0/CPU0:router(#admin)# show license backup disk1:/license_back</td>
</tr>
<tr>
<td><strong>Step 3</strong></td>
<td><strong>license restore backup-file</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Example:</strong></td>
</tr>
<tr>
<td></td>
<td>RP/0/RSP0/CPU0:router(#admin)# license restore disk1:/license_back</td>
</tr>
</tbody>
</table>

Examples

This example shows sample output from the `license restore` command.

```
RP/0/RSP0/CPU0:router(#admin)# license restore disk1:/license_back
Info: This command will erase all existing licenses.
Info: It is strongly recommended to backup existing licenses first.
Do you wish to proceed? [yes/no]: y
License command "license restore disk1:/license_back" completed successfully.
```

Transferring Licenses to a new Route Switch Processor 440

To upgrade a route switch processor (RSP) to the RSP440 with your active licenses, perform this task.
SUMMARY STEPS

1. Save the original license file that you received from Cisco, in a USB drive or TFTP server.
2. `save configuration running`
3. Replace the RSP with the RSP440.
4. `load`
5. Add all licenses as described in Adding a License for a New Feature, on page 382.

DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td>Save the original license file that you received from Cisco, in a USB drive or TFTP server.</td>
</tr>
</tbody>
</table>
| **Step 2** | `save configuration running`  
**Example:**  
RP/0/RSP0/CP00:router# configure  
RP/0/RSP0/CP00:router(config)# save configuration running tftp://192.10.10.10/mylicenses/rc_03132013  
RP/0/RSP0/CP00:router(config)# exit  
RP/0/RSP0/CP00:router# admin  
RP/0/RSP0/CP00:router(admin)# configure  
RP/0/RSP0/CP00:router(admin-config)# save configuration running  
`tftp://192.10.10.10/mylicenses/rc_admin_03132013` | Saves the running-configuration from both global configuration and administration configuration modes to files. The administration configuration contains user group information that is required for the licenses. |
| **Step 3** | Replace the RSP with the RSP440. |  |
| **Step 4** | `load`  
**Example:**  
RP/0/RSP0/CP00:router# configure  
RP/0/RSP0/CP00:router(config)# load  
`tftp://192.10.10.10/mylicenses/rc_03132013`  
RP/0/RSP0/CP00:router(config)# exit  
RP/0/RSP0/CP00:router# admin  
RP/0/RSP0/CP00:router(admin)# configure  
RP/0/RSP0/CP00:router(admin-config)# load  
`tftp://192.10.10.10/mylicenses/rc_admin_03132013` | Loads the saved running-configuration files on the new RSP440. This must be done in both global configuration mode and administration configuration mode. |
| **Step 5** | Add all licenses as described in Adding a License for a New Feature, on page 382. | Installs the licenses to the new RSP. |

Upgrading Line Cards and Licenses

You may have a number of licenses running on the line cards in your router. Before you upgrade these line cards to advanced models, you need to install new licenses that are appropriate for these line cards. This task describes the steps necessary to upgrade your line cards and their licenses.
Before you begin

- You must have purchased all relevant licenses for the line cards that you are upgrading, prior to performing this task.
- You must have placed the license files on your router disk drive or a TFTP server such that they accessible from your router. Refer to Adding a License for a New Feature, on page 382 for more information.

SUMMARY STEPS

1. admin
2. license add license-name
3. configure
4. license license-name location {all | node-id }
5. Remove the old line cards and install the new ones.
6. show license

DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> admin</td>
<td>Enters administration EXEC mode.</td>
</tr>
<tr>
<td><strong>Example:</strong> RP/0/RSP0/CPU0:router# admin</td>
<td></td>
</tr>
<tr>
<td><strong>Step 2</strong> license add license-name</td>
<td>Adds the license to the license pool.</td>
</tr>
<tr>
<td><strong>Example:</strong> RP/0/RSP0/CPU0:router(admin)# license add tftp://192.10.10.10/mylicenses/A9K-24X10G-AIP-TR-lic</td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong> configure</td>
<td>Enters administration configuration mode.</td>
</tr>
<tr>
<td><strong>Example:</strong> RP/0/RSP0/CPU0:router(admin)# configure</td>
<td></td>
</tr>
<tr>
<td><strong>Step 4</strong> license license-name location {all</td>
<td>node-id }</td>
</tr>
<tr>
<td><strong>Example:</strong> RP/0/RSP0/CPU0:router(admin-config)# license A9K-24X10G-AIP-TR location 0/0/CPU0</td>
<td><strong>Note</strong> Beginning with Cisco IOS XR Release 4.3.1, this command is optional. If you do not use this command, it is configured as though the license is bound to all slots.</td>
</tr>
<tr>
<td><strong>Step 5</strong> Remove the old line cards and install the new ones.</td>
<td>Associates the new license on the slot with the new line card.</td>
</tr>
<tr>
<td><strong>Note</strong> You need to wait for the new line cards to boot.</td>
<td></td>
</tr>
<tr>
<td><strong>Step 6</strong> show license</td>
<td>Verifies the status of the licenses.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
</tbody>
</table>
**Troubleshooting License Issues after a Software Upgrade**

In the instance that you were running Cisco IOS XR Release 3.9.0 and had the optic feature enabled on an interface and the A9K-ADV-OPTIC-LIC license was active on a particular slot, when you upgrade to Cisco IOS XR Release 4.0.0, the A9K-ADV-OPTIC-LIC license is still active, but you may get the following warning message:

```
RP/0/RSP0/CPU0:Jul 27 14:22:22.594 : licmgr[236]:
%LICENSE-LICMGR-4-PACKAGE_LOCATION_LICENSE_INVALID :
Feature associated to package A9K-ADV-OPTIC-LIC configured
on node 0/4/CPU0 without a valid license
```

To solve this issue, configure the `license` command in administration EXEC mode. This binds the A9K-ADV-OPTIC-LIC license to the slot on which you are using the license. For example:

```
RP/0/RSP0/CPU0:router(admin-config)# license A9K-ADV-OPTIC-LIC location 0/4/CPU0
RP/0/RSP0/CPU0:router(admin-config)# commit
```
Troubleshooting License Issues after a Software Upgrade
Configuring Frequency Synchronization

Frequency Synchronization is used to distribute precision frequency around a network. Frequency is synchronized accurately using Synchronized Ethernet (SyncE) in devices connected by Ethernet in a network. This module describes the concepts around this and details the various configurations involved. For information on SyncE commands, see System Management Command Reference for Cisco ASR 9000 Series Routers.

This module contains the following topics:

- Overview, on page 391
- Configuring Frequency Synchronization, on page 394

Overview

Frequency or timing synchronization is the ability to distribute precision frequency around a network. In this context, timing refers to precision frequency, not an accurate time of day. Precision frequency is required in next generation networks for applications such as circuit emulation.

To achieve compliance to ITU specifications for TDM, differential method circuit emulation must be used, which requires a known, common precision frequency reference at each end of the emulated circuit. The incumbent example of frequency synchronization is provided by SDH equipment. This is used in conjunction with an external timing technology to provide synchronization of precision timing across the network.

SDH equipments are widely replaced by Ethernet equipments and synchronized frequency is required over such Ethernet ports. Synchronous Ethernet (SyncE) is used to accurately synchronize frequency in devices connected by Ethernet in a network. SyncE provides level frequency distribution of known common precision frequency references to a physical layer Ethernet network.

To maintain SyncE links, a set of operational messages are required. These messages ensure that a node is always deriving timing information from the most reliable source and then transfers the timing source quality information to clock the SyncE link. In SDH networks, these are known as Synchronization Status Messages (SSMs). SyncE uses Ethernet Synchronization Message Channel (ESMC) to provide transport for SSMs.

Source and Selection Points

Frequency Synchronization implementation involves Sources and Selection Points.

A Source inputs frequency signals into a system or transmits them out of a system. There are four types of sources:

- Line interfaces. This includes SyncE interfaces and SONET interfaces.
- Clock interfaces. These are external connectors for connecting other timing signals, such as BITS, UTI and GPS.
- PTP clock. If IEEE 1588 version 2 is configured on the router, a PTP clock may be available to frequency synchronization as a source of the time-of-day and frequency.
- Internal oscillator. This is a free-running internal oscillator chip.

Each source has a Quality Level (QL) associated with it which gives the accuracy of the clock. This QL information is transmitted across the network using ESMC or SSMs contained in the SDH frames. This provides information about the best available source the devices in the system can synchronize to. To define a predefined network synchronization flow and prevent timing loops, you can assign priority values to the sources on each router. The combination of QL information and user-assigned priority levels allow each router to choose a source to synchronize its SyncE or SDH interfaces, as described in the ITU standard G.781.

A Selection Point is any point where a choice is made between several frequency signals and possibly one or many of them are selected. Selection points form a graph representing the flow of timing signals between different cards in a router running Cisco IOS XR software. For example, there can be one or many selection points between different Synchronous Ethernet inputs available on a single line card. This information is forwarded to a selection point on the RSP, to choose between the selected source from each card.

The input signals to the selection points can be:
- Received directly from a source.
- Received as the output from another selection point on the same card.
- Received as the output from a selection point on a different card.

The output of a selection point can be used in a number of ways, like:
- To drive the signals sent out of a set of interfaces.
- As input into another selection point on a card.
- As input into a selection point on another card.

Use `show frequency synchronization selection` command to see a detailed view of the different selection points within the system.

**SyncE Hardware Support Matrix**

This table provides details on the hardware that supports SyncE:

<table>
<thead>
<tr>
<th>Hardware Variant</th>
<th>Cisco IOS XR</th>
<th>Cisco IOS XR 64 bit</th>
</tr>
</thead>
<tbody>
<tr>
<td>A9K-8X100GE-L-SE/TR (10GE and 100GE)</td>
<td>5.3.0</td>
<td>6.1.1</td>
</tr>
<tr>
<td>A9K-RSP880-SE/TR</td>
<td>5.3.0</td>
<td>6.1.1</td>
</tr>
</tbody>
</table>

**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.
### SyncE Restrictions

This section lists a few restrictions in configuring frequency synchronization. They are:

- On SyncE line interfaces, only one interface from each PHY can be configured as SyncE input (there is no restriction on SyncE output) on the A9K-24X10GE-1G-SE/TR and A9K-48X10GE-1G-SE/TR line cards.

<table>
<thead>
<tr>
<th>Hardware Variant</th>
<th>Cisco IOS XR</th>
<th>Cisco IOS XR 64 bit</th>
</tr>
</thead>
<tbody>
<tr>
<td>A9K-8X100GE-L-SE/TR (40-GE)</td>
<td>6.0.1</td>
<td>6.1.1</td>
</tr>
<tr>
<td>A9K-4X100GE-SE/TR</td>
<td>5.3.2 (100G LAN only)</td>
<td>6.1.1</td>
</tr>
<tr>
<td>A9K-8X100GE-SE/TR</td>
<td>6.0.1</td>
<td></td>
</tr>
<tr>
<td>A9K-MOD400-SE/TR</td>
<td>6.0.1</td>
<td></td>
</tr>
<tr>
<td>A9K-MOD200-SE/TR with MPA 20x10GE and Legacy MPAs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A9K-MOD400-SE/TR</td>
<td>6.1.3</td>
<td></td>
</tr>
<tr>
<td>A9K-MOD200-SE/TR with MPAs 2x100 and 1x100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A9K-400G-DWDM-TR</td>
<td>5.3.3</td>
<td>6.0.1</td>
</tr>
<tr>
<td>A9K-24X10GE-1G-SE/TR</td>
<td>6.2.1</td>
<td>6.3.2</td>
</tr>
<tr>
<td>A9K-48X10GE-1G-SE/TR</td>
<td>6.0.1</td>
<td></td>
</tr>
<tr>
<td>A99-RSP-SE/TR (Cisco ASR 9910 Series Routers)</td>
<td>6.1.4</td>
<td>6.3.2</td>
</tr>
<tr>
<td>RSP880-LT-SE/TR</td>
<td>6.2.2</td>
<td>6.4.1</td>
</tr>
<tr>
<td>A9K-RSP440-TR/SE Enhanced Ethernet Linecards</td>
<td>4.3.4</td>
<td></td>
</tr>
<tr>
<td>A99-RP-SE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A99-RP2-TR/SE</td>
<td>5.3.0</td>
<td>6.3.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.4.1</td>
</tr>
<tr>
<td>Cisco ASR 9001 Series Routers</td>
<td>4.3.4</td>
<td></td>
</tr>
<tr>
<td>Cisco ASR 9901 Series Routers</td>
<td></td>
<td>6.4.1</td>
</tr>
<tr>
<td>A99-RSP-SE/TR (Cisco ASR 9906 Series Routers)</td>
<td>6.3.1</td>
<td>6.3.2</td>
</tr>
</tbody>
</table>
Configuring Frequency Synchronization

Enabling Frequency Synchronization on the Router

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

SUMMARY STEPS

1. configure
2. frequency synchronization
3. clock-interface timing-mode \{independent | system\}
4. quality itu-t option \{1 | 2\} generation \{1 | 2\}
5. log selection \{changes | errors\}
6. Use one of these commands:
   - end
   - commit

DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td>configure</td>
</tr>
<tr>
<td><strong>Step 2</strong></td>
<td>frequency synchronization</td>
</tr>
<tr>
<td>Example:</td>
<td>RP/0/RSP0/CFU0:router(config)# frequency synchronization</td>
</tr>
<tr>
<td></td>
<td>Enables frequency synchronization on the router.</td>
</tr>
<tr>
<td><strong>Step 3</strong></td>
<td>clock-interface timing-mode {independent</td>
</tr>
<tr>
<td>Example:</td>
<td>RP/0/RSP0/CFU0:router(config-freqsync)# clock-interface timing-mode system</td>
</tr>
<tr>
<td></td>
<td>(Optional) Configures the type of timing sources that can be used to drive the output from a clock interface. If this command is not used, the default quality mode is used. In the default mode, the clock interface output is driven only by input from line interfaces and the internal oscillator; it is never driven by input from another clock interface. In addition, some heuristic tests are run to detect if the signal being sent out of one clock interface can be looped back by some external box and sent back in via the same, or another clock interface.</td>
</tr>
<tr>
<td></td>
<td>• independent—Specifies that the output of clock interfaces is driven only by the line interfaces (SyncE and SONET/SDH), as in the default mode. Loopback detection is disabled.</td>
</tr>
</tbody>
</table>
| | • system—Specifies that the output of a clock interface is driven by the system-selected timing source (the source used to drive all SyncE and SONET/SDH
<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 4</strong> quality itu-t option {1 | 2 generation {1 | 2}}</td>
<td>(Optional) Specifies the quality level for the router. The default is option 1.</td>
</tr>
<tr>
<td>Example: RP/0/RSP0/CPU0:router(config-freqsync)# quality itu-t option 2 generation 1</td>
<td>• option 1—Includes PRC, SSU-A, SSU-B, SEC and DNU.</td>
</tr>
<tr>
<td></td>
<td>• option 2 generation 1—Includes PRS, STU, ST2, ST3, SMC, ST4, RES and DUS.</td>
</tr>
<tr>
<td></td>
<td>• option 2 generation 2—Includes PRS, STU, ST2, ST3, TNC, ST3E, SMC, ST4, PROV and DUS.</td>
</tr>
<tr>
<td><strong>Note</strong></td>
<td>The quality option configured here must match the quality option specified in the quality receive and quality transmit commands in interface frequency synchronization configuration mode.</td>
</tr>
<tr>
<td><strong>Step 5</strong> log selection {changes | errors}</td>
<td>Enables logging to frequency synchronization.</td>
</tr>
<tr>
<td>Example: RP/0/RSP0/CPU0:router(config-freqsync)# log selection changes</td>
<td>• changes—Logs every time there is a change to the selected source, in addition to errors.</td>
</tr>
<tr>
<td></td>
<td>• errors—Logs only when there are no available frequency sources, or when the only available frequency source is the internal oscillator.</td>
</tr>
<tr>
<td><strong>Step 6</strong> Use one of these commands: • end • commit</td>
<td>Saves configuration changes.</td>
</tr>
<tr>
<td>Example: RP/0/RSP0/CPU0:router(config-freqsync)# end or RP/0/RSP0/CPU0:router(config-freqsync)# commit</td>
<td>• When you issue the end command, the system prompts you to commit changes:</td>
</tr>
<tr>
<td></td>
<td>Uncommitted changes found, commit them before exiting(yes/no/cancel)? [cancel]:</td>
</tr>
<tr>
<td></td>
<td>• Entering yes saves configuration changes to the running configuration file, exits the configuration session, and returns the router to EXEC mode.</td>
</tr>
<tr>
<td></td>
<td>• Entering no exits the configuration session and returns the router to EXEC mode without committing the configuration changes.</td>
</tr>
<tr>
<td></td>
<td>• Entering cancel leaves the router in the current configuration session without exiting or committing the configuration changes.</td>
</tr>
<tr>
<td></td>
<td>• Use the commit command to save the configuration changes to the running configuration file, and remain within the configuration session.</td>
</tr>
</tbody>
</table>
What to do next
Configure frequency synchronization on any interfaces that should participate in frequency synchronization.

Configuring Frequency Synchronization on an Interface
By default, there is no frequency synchronization on line interfaces. Use this task to configure an interface to participate in frequency synchronization.

Before you begin
You must enable frequency synchronization globally on the router.

SUMMARY STEPS
1. configure
2. interface type interface-path-id
3. frequency synchronization
4. selection input
5. priority priority-value
6. wait-to-restore minutes
7. ssm disable
8. time-of-day-priority priority
9. quality transmit {exact | highest | lowest} itu-t option ql-option
10. quality receive {exact | highest | lowest} itu-t option ql-option
11. Use one of these commands:
   • end
   • commit

DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1 configure</td>
<td>Enter interface configuration mode.</td>
</tr>
<tr>
<td>Step 2 interface type interface-path-id</td>
<td>Enables frequency synchronization on the interface and enters interface frequency synchronization mode to configure the various options. By default, this causes the system selected frequency signal to be used for clocking transmission, but does not enable the use of the interface as an input.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>RP/0/RSP0/CPU0:router(config)# interface GigabitEthernet0/1/1/0</td>
<td></td>
</tr>
<tr>
<td>Step 3 frequency synchronization</td>
<td></td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>RP/0/RSP0/CPU0:router(config-if)# frequency synchronization</td>
<td></td>
</tr>
<tr>
<td>Step 4 selection input</td>
<td>(Optional) Specifies the interface as a timing source to be passed to the selection algorithm.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
</tbody>
</table>
### Configuring Frequency Synchronization on an Interface

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>RP/0/RSP0/CPU0:router(config-if-freqsync)# selection input</td>
<td>(Optional) Configures the priority of the frequency source on a controller or an interface. Values can range from 1 (highest priority) to 254 (lowest priority). The default value is 100. This command is used to set the priority for an interface or clock interface. The priority is used in the clock-selection algorithm to choose between two sources that have the same quality level (QL). Lower priority values are preferred.</td>
</tr>
<tr>
<td>Step 5 priority priority-value</td>
<td></td>
</tr>
<tr>
<td>Example: RP/0/RSP0/CPU0:router(config-if-freqsync)# priority 100</td>
<td></td>
</tr>
<tr>
<td>Step 6 wait-to-restore minutes</td>
<td>(Optional) Configures the wait-to-restore time, in minutes, for frequency synchronization on an interface. This is the amount of time after the interface comes up before it is used for synchronization. Values can range from 0 to 12. The default value is 5.</td>
</tr>
<tr>
<td>Example: RP/0/RSP0/CPU0:router(config-if-freqsync)# wait-to-restore 300</td>
<td></td>
</tr>
<tr>
<td>Step 7 ssm disable</td>
<td>(Optional) Disables Synchronization Status Messages (SSMs) on the interface.</td>
</tr>
<tr>
<td>Example: RP/0/RSP0/CPU0:router(config-if-freqsync)# ssm disable</td>
<td>• For SyncE interfaces, this disables sending ESMC packets, and ignores any received ESMC packets. • For SONET and clock interfaces, this causes DNUs to be sent, and ignores any received QL value.</td>
</tr>
<tr>
<td>Step 8 time-of-day-priority priority</td>
<td>(Optional) Specifies the priority of this time source as the time-of-day (ToD) source. The priority is used as the first criterion when selecting between sources for a time-of-day selection point. Values can range from 1 (highest priority) to 254 (lowest priority); the default value is 100.</td>
</tr>
<tr>
<td>Example: RP/0/RSP0/CPU0:router(config-if-freqsync)# time-of-day-priority 50</td>
<td></td>
</tr>
<tr>
<td>Step 9 quality transmit {exact</td>
<td>highest</td>
</tr>
<tr>
<td>Example: RP/0/RSP0/CPU0:router(config-clk-freqsync)# quality transmit highest itu-t option 1 prc</td>
<td>• <strong>exact ql</strong>—Specifies the exact QL to send, unless DNU would otherwise be sent. • <strong>highest ql</strong>—Specifies an upper limit on the QL to be sent. If the selected source has a higher QL than the QL specified here, this QL is sent instead. • <strong>lowest ql</strong>—Specifies a lower limit on the QL to be sent. If the selected source has a lower QL than the QL specified here, DNU is sent instead. The quality option specified in this command must match the globally-configured quality option in the <strong>quality itu-t option</strong> command.</td>
</tr>
</tbody>
</table>
## Configuring Frequency Synchronization on an Interface

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 10</strong> quality receive {exact</td>
<td>highest</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>RP/0/RSP0/CPU0:router(config-clk-freqsync)# quality receive highest itu-t option 1 prc</td>
<td>• <strong>exact qL</strong>—Specifies the exact QL regardless of the value received, unless the received value is DNU.</td>
</tr>
<tr>
<td></td>
<td>• <strong>highest qL</strong>—Specifies an upper limit on the received QL. If the received value is higher than this specified QL, this QL is used instead.</td>
</tr>
<tr>
<td></td>
<td>• <strong>lowest qL</strong>—Specifies a lower limit on the received QL. If the received value is lower than this specified QL, DNU is used instead.</td>
</tr>
<tr>
<td>The quality option specified in this command must match the globally-configured quality option in the <strong>quality itu-t option</strong> command.</td>
<td></td>
</tr>
<tr>
<td><strong>Note</strong></td>
<td>For clock interfaces that do not support SSM, only the exact QL can be specified.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 11</strong> Use one of these commands:</td>
<td>Saves configuration changes.</td>
</tr>
<tr>
<td>• end</td>
<td>When you issue the end command, the system prompts you to commit changes:</td>
</tr>
<tr>
<td>• commit</td>
<td>Uncommitted changes found, commit them before exiting(yes/no/cancel)? [cancel]:</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>RP/0/RSP0/CPU0:router(config-if-freqsync)# end</td>
<td>• Entering <strong>yes</strong> saves configuration changes to the running configuration file, exits the configuration session, and returns the router to EXEC mode.</td>
</tr>
<tr>
<td>or</td>
<td>• Entering <strong>no</strong> exits the configuration session and returns the router to EXEC mode without committing the configuration changes.</td>
</tr>
<tr>
<td>RP/0/RSP0/CPU0:router(config-if-freqsync)# commit</td>
<td>• Entering <strong>cancel</strong> leaves the router in the current configuration session without exiting or committing the configuration changes.</td>
</tr>
<tr>
<td></td>
<td>• Use the commit command to save the configuration changes to the running configuration file, and remain within the configuration session.</td>
</tr>
</tbody>
</table>
Verifying the Frequency Synchronization Configuration

After performing the frequency synchronization configuration tasks, use this task to check for configuration errors and verify the configuration.

SUMMARY STEPS

1. show frequency synchronization configuration-errors
2. show frequency synchronization interfaces brief
3. show frequency synchronization interfaces node-id
4. show processes fsyncmgr location node-id

DETAILED STEPS

Step 1  show frequency synchronization configuration-errors

Example:

RP/0/RSP0/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 GigabitEthernet0/2/0/1 frequency synchronization quality transmit exact itu-t option 2
generation 1 PRS
  * The QL that is configured is from a different QL option set than is configured globally.

Displays any errors that are caused by inconsistencies between shared-plane (global) and local-plane (interface) configurations. There are two possible errors that can be displayed:

- Frequency Synchronization is configured on an interface (line interface or clock-interface), but is not configured globally. Refer to Enabling Frequency Synchronization on the Router, on page 394

- The QL option configured on some interface does not match the global QL option. Under an interface (line interface or clock interface), the QL option is specified using the quality transmit and quality receive commands. The value specified must match the value configured in the global quality itu-t option command, or match the default (option 1) if the global quality itu-t option command is not configured.

Once all the errors have been resolved, meaning there is no output from the command, continue to the next step.

Step 2  show frequency synchronization interfaces brief

Example:

RP/0/RSP0/CPU0:router# show frequency synchronization interfaces brief

Flags: > - Up D - Down S - Assigned for selection
d - SSM Disabled x - Peer timed out i - Init state
F1 Interface QLrcv QLuse Pri QLsnt Source
--- ----------------- ------ ---- ----- -------------------
>Sx GigabitEthernet0/2/0/0 Fail Fail 100 DNU None
Dd GigabitEthernet0/2/0/1 n/a Fail 100 n/a None
Verifying the Frequency Synchronization Configuration

RP/0/RSP0/CPU0:router# show frequency synchronization clock-interfaces brief

Flags: > - Up  D - Down  S - Assigned for selection
       d - SSM Disabled  s - Output squelched  l - Looped back

Node 0/0/CPU0:

<table>
<thead>
<tr>
<th>Fl</th>
<th>Clock Interface</th>
<th>QLrcv</th>
<th>QLuse</th>
<th>Pri</th>
<th>QLand</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;S</td>
<td>Sync0</td>
<td>PRC</td>
<td>Fail</td>
<td>100</td>
<td>SSU-B</td>
<td>Internal0 [0/0/CPU0]</td>
</tr>
<tr>
<td>&gt;</td>
<td>Sync1</td>
<td>SSU-A</td>
<td>Fail</td>
<td>100</td>
<td>SSU-B</td>
<td>Internal0 [0/0/CPU0]</td>
</tr>
<tr>
<td>&gt;S</td>
<td>Internal0</td>
<td>n/a</td>
<td>SSU-B</td>
<td>255</td>
<td>n/a</td>
<td>None</td>
</tr>
</tbody>
</table>

Node 0/1/CPU0:

<table>
<thead>
<tr>
<th>Fl</th>
<th>Clock Interface</th>
<th>QLrcv</th>
<th>QLuse</th>
<th>Pri</th>
<th>QLand</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>D</td>
<td>Sync0</td>
<td>None</td>
<td>Fail</td>
<td>100</td>
<td>SSU-B</td>
<td>Internal0 [0/1/CPU0]</td>
</tr>
<tr>
<td>D</td>
<td>Sync1</td>
<td>None</td>
<td>Fail</td>
<td>100</td>
<td>SSU-B</td>
<td>Internal0 [0/1/CPU0]</td>
</tr>
<tr>
<td>&gt;S</td>
<td>Internal0</td>
<td>n/a</td>
<td>SSU-B</td>
<td>255</td>
<td>n/a</td>
<td>None</td>
</tr>
</tbody>
</table>

Verifies the configuration. Note the following points:

- All line interface that have frequency synchronization configured are displayed.
- All clock interfaces and internal oscillators are displayed.
- Sources that have been nominated as inputs (in other words, have selection input configured) have ‘S’ in the Flags column; sources that have not been nominated as inputs do not have ‘S’ displayed.

  Note: Internal oscillators are always eligible as inputs.

- ‘>’ or ‘D’ is displayed in the flags field as appropriate.

If any of these items are not true, continue to the next step.

**Step 3** show frequency synchronization interfaces node-id

**Example:**

RP/0/RSP0/CPU0:router# show frequency synchronization interfaces GigabitEthernet0/2/0/2

Interface GigabitEthernet0/2/0/2 (shutdown)
  Assigned as input for selection
  SSM Enabled
  Input:
    Down
    Last received QL: Failed
    Effective QL: Failed, Priority: 100
  Output:
    Selected source: Sync0 [0/0/CPU0]
    Selected source QL: Opt-1/PRC
    Effective QL: Opt-1/PRC
    Next selection points: LC_INGRESS

RP/0/RSP0/CPU0:router# show frequency synchronization clock-interfaces location 0/1/CPU0

Node 0/1/CPU0:

Clock interface Sync0 (Down: mode not configured)
SSM supported and enabled
Input:
  Down
Last received QL: Opt-I/PRC
Effective QL: Failed, Priority: 100
Output:
  Selected source: Internal0 [0/1/CPU0]
  Selected source QL: Opt-I/SSU-B
  Effective QL: Opt-I/SSU-B
Next selection points: RP_SYSTEM

Clock interface Sync1 (Down: mode not configured)
SSM supported and enabled
Input:
  Down
Last received QL: Opt-I/PRC
Effective QL: Failed, Priority: 100
Output:
  Selected source: Internal0 [0/1/CPU0]
  Selected source QL: Opt-I/SSU-B
  Effective QL: Opt-I/SSU-B
Next selection points: RP_SYSTEM

Clock interface Internal0 (Up)
  Assigned as input for selection
Input:
  Default QL: Opt-I/SSU-B
  Effective QL: Opt-I/SSU-B, Priority: 255
Next selection points: RP_SYSTEM RP_CLOCK_INTF

Investigates issues within individual interfaces. If the clock interface is down, a reason is displayed. This may be because there is missing or conflicting platform configuration on the clock interface.

Step 4  show processes fsyncmgr location node-id

Example:

RP/0/RSP0/CPU0:router# show processes fsyncmgr location 0/0/CPU0

  Job Id: 134
  PID: 30202
  Executable path: /pkg/bin/fsyncmgr
  Instance #: 1
  Version ID: 00.00.0000
  Respawn: ON
  Respawn count: 1
  Max. spawns per minute: 12
  Last started: Mon Mar 9 16:30:43 2009
  Process state: Run
  Package state: Normal
  Started on config: cfg/gl/freqsync/g/a/enable
  core: MAINMEM
  Max. core: 0
  Placement: None
  startup_path: /pkg/startup/fsyncmgr.startup
  Ready: 0.133s
  Process cpu time: 1730768.741 user, -133848.-361 kernel, 1596920.380 total

------------------------------------------------------------------
Verifying the Frequency Synchronization Configuration

Verifies that the fsyncmgr process is running on the appropriate nodes.
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. For information on PTP commands, see System Management Command Reference for Cisco ASR 9000 Series Routers.

This module contains the following topics:

- Overview, on page 403
- ITU-T Telecom Profiles for PTP, on page 413
- Configuring PTP, on page 416
- Configuration Examples, on page 431

### 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 49: PTP Clocks

<table>
<thead>
<tr>
<th>Network Element</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grandmaster (GM)</td>
<td>A network device physically attached to the primary time source. All clocks are synchronized to the grandmaster clock.</td>
</tr>
</tbody>
</table>
### Network Element | Description
--- | ---
**Ordinary Clock (OC)** | An ordinary clock is a 1588 clock with a single PTP port that can operate in one of the following modes:
- **Master mode**—Distributes timing information over the network to one or more slave clocks, thus allowing the slave to synchronize its clock to the master.
- **Slave mode**—Synchronizes its clock to a master clock. You can enable the slave mode on up to two interfaces simultaneously in order to connect to two different master clocks.

**Boundary Clock (BC)** | The device participates in selecting the best master clock and can act as the master clock if no better clocks are detected.

Boundary clock starts its own PTP session with a number of downstream slaves. The boundary clock mitigates the number of network hops and results in packet delay variations in the packet network between the Grand Master and Slave.

**Transparent Clock (TC)** | A transparent clock is a device or a switch that calculates the time it requires to forward traffic and updates the PTP time correction field to account for the delay, making the device transparent in terms of time calculations.

PTP consists of two parts:

- **The port State machine and Best Master Clock Algorithm**: This provides a method to determine 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 mechanism for slave ports to calculate the difference between the time of their own clocks and the time of their master clock.

**Note**
Cisco ASR 9000 Series routers do not support Peer-delay mechanism.

The implementation of PTP on Cisco IOS XR software is designed to operate effectively in Telecommunication networks, which are different from the networks for which PTP was originally designed.

PTP is configurable on Gigabit Ethernet interfaces (1G, 10G, 40G, and 100G), Bundle Ethernet interfaces, and sub-interfaces. PTP is not configurable on LAG Ethernet sub-interfaces.
**Frequency and Time Selection**

The selection of the source to synchronize the backplane 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, DTI 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.871, and is described in the Configuring Frequency Synchronization module in this document. The ToD selection is controlled using the time-of-day priority configuration. This configuration is found under the source 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.

**Port States**

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

<table>
<thead>
<tr>
<th>State</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>INIT</td>
<td>Port is not ready to participate in PTP.</td>
</tr>
<tr>
<td>LISTENING</td>
<td>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.</td>
</tr>
<tr>
<td>PRE-MASTER</td>
<td>Port is ready to enter the MASTER state.</td>
</tr>
<tr>
<td>MASTER</td>
<td>Port provides timestamps for any Slave or boundary clocks that are listening.</td>
</tr>
<tr>
<td>UNCALIBRATED</td>
<td>Port receives timestamps from a Master clock but, the router’s clock is not yet synchronized to the Master.</td>
</tr>
</tbody>
</table>
### GPS ToD Support for NMEA

National Marine Electronics Associations (NMEA) 0183 is a standard protocol used by GPS receivers to transmit data and is responsible for creating a standard uniform interface for digital data exchange between different marine electronic products. NMEA provides protocol strings to send out GPS updates. GPRMC is one such NMEA string that provides exact data and time (Greenwich time), latitude, longitude, heading, and speed. Router receives GPS ToD messages in serial ASCII stream through the RS422 interface in three formats - NTP Type 4, Cisco, and GPRMC. The timing data is extracted from this stream.

**Note**

Cisco ASR 9000 Series Routers can support ToD in NMEA or GPRMC format. Currently, this is supported only on RS422.

**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.

Supported hardware are:

- A9K-RSP440-SE/TR
- A9K-RSP880-SE/TR
- A99-RP2-SE/TR
- RSP880-LT-SE/TR

### PTP Support Information

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

| Transport Media | • UDP over IPv4  
|                 | • Ethernet  
|                 | • IPv6       |
Messages

- Signaling
- Announce
- Sync
- Follow-up
- Delay-request
- Delay-response
- Management

Transport Modes

- Unicast: This is the default mode. All packets are sent as unicast messages.
- Mixed: Announce and Sync messages are sent as multicast messages. Signaling, Delay-request, and Delay-response messages are sent as unicast messages.
- Multicast: All packets are sent as multicast messages.

PTP Hardware Support Matrix

This table provides a detailed information on the supported hardware:

<table>
<thead>
<tr>
<th>Hardware Variant</th>
<th>1588/PTP</th>
<th>Cisco IOS XR</th>
<th>Cisco IOS XR 64 bit</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>A9K-8X100GE5-SE/TR (10GE and 100GE)</td>
<td>Default &amp; G.8265.1</td>
<td>5.3.3</td>
<td>6.3.2</td>
<td>PTP over Ethernet does not work on 100G ports on Cisco IOS XR until 6.4.1. Support was introduced in 6.4.1.</td>
</tr>
<tr>
<td>G.8275.1 &amp; G.8275.2</td>
<td>6.2.1</td>
<td>6.3.2</td>
<td>6.4.1</td>
<td></td>
</tr>
<tr>
<td>G.8273.2</td>
<td>6.2.1</td>
<td>6.3.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>RSP IEEE 1588 port</td>
<td>NA</td>
<td>NA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PTP Interoperability</td>
<td>NA</td>
<td>6.5.1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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.
<table>
<thead>
<tr>
<th>Hardware Variant</th>
<th>1588/PTP</th>
<th>Cisco IOS XR</th>
<th>Cisco IOS XR 64 bit</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>A9K-RSP880-SE/TR</td>
<td>1588/PTP</td>
<td>5.3.3</td>
<td>6.3.2</td>
<td>PTP over Ethernet does not work on 100G ports on Cisco IOS XR until 6.4.1. Support was introduced in 6.4.1. In 6.2.1, only G.8275.1 PTP profile is supported on the cards; No support for G.8273.2 PTP profile.</td>
</tr>
<tr>
<td></td>
<td>Default &amp; G.8265.1</td>
<td>6.4.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1588/PTP</td>
<td>6.2.1</td>
<td>6.3.2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>G.8275.1 &amp; G.8275.2</td>
<td>6.4.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1588/PTP</td>
<td>6.2.1</td>
<td>6.3.2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>G.8273.2</td>
<td>6.4.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>RSP IEEE 1588 port</td>
<td>6.2.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>PTP Interoperability</td>
<td>NA</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>A9K-8X100GE-L-SE/TR (40-GE)</td>
<td>1588/PTP</td>
<td>6.0.1</td>
<td>6.3.2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Default &amp; G.8265.1</td>
<td>6.4.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1588/PTP</td>
<td>6.2.1</td>
<td>6.3.2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>G.8275.1 &amp; G.8275.2</td>
<td>6.4.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1588/PTP</td>
<td>6.2.1</td>
<td>6.3.2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>G.8273.2</td>
<td>6.4.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>RSP IEEE 1588 port</td>
<td>NA</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td></td>
<td>PTP Interoperability</td>
<td>NA</td>
<td>6.5.1</td>
<td></td>
</tr>
<tr>
<td>Hardware Variant</td>
<td>1588/PTP</td>
<td>Cisco IOS XR</td>
<td>Cisco IOS XR 64 bit</td>
<td>Comments</td>
</tr>
<tr>
<td>------------------</td>
<td>---------</td>
<td>-------------</td>
<td>------------------</td>
<td>----------</td>
</tr>
<tr>
<td>A9K-MOD400-SE/TR &amp; A9K-MOD200-SE/TR with MPA 20x10GE and Legacy MPAs</td>
<td>1588/PTP</td>
<td>6.1.3</td>
<td>6.4.1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Default &amp; G.8265.1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1588/PTP</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>G.8275.1 &amp; G.8275.2</td>
<td>6.2.2</td>
<td>6.4.1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1588/PTP</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>G.8273.2</td>
<td></td>
<td>6.5.1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>RSP IEEE 1588 port</td>
<td>NA</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td></td>
<td>PTP Interoperability</td>
<td>NA</td>
<td>6.5.1</td>
<td></td>
</tr>
<tr>
<td>A9K-MOD400-SE/TR &amp; A9K-MOD200-SE/TR with MPAs 2x100 and 1x100</td>
<td>1588/PTP</td>
<td>6.1.3</td>
<td>6.4.1</td>
<td>PTP over Ethernet does not work on 100G ports on Cisco IOS XR until 6.4.1. Support was introduced in 6.4.1. In 6.2.2, only G.8275.1 PTP profile is supported on the cards; No support for G.8273.2 PTP profile.</td>
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<td></td>
<td>Enhanced Ethernet based hardware does not support G.8273.2 with G.8275.1 PTP profile.</td>
</tr>
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</table>
## Restrictions

- Two-step clock operation is recommended over one-step clock operation for a PTP Master.
- 1 Pulse per Second (1PPS) output is not supported on Cisco ASR 9000 Series Routers.
- One-step clock operation on G.8275.1 profile is not supported on a PTP Master.
- G.8275.1 and G.8275.2 profiles are not supported on Cisco ASR 9001 chassis, Cisco ASR 9000 Ethernet line cards, Cisco ASR 9000 Enhanced Ethernet line cards, and A9K-400G-DWDM-SE/TR line cards.
- As recommended in Appendix VI of ITU-T G.8275.1 document, G.8275.1 profile is supported only on Bundle Link Aggregation (LAG) member links and not supported on a bundle interface.
- G.8273.2 Telecom Boundary Clock (T-BC) performance is not supported on 40G interfaces.
- The G.8273.2 Class B performance is observed when the same type of line card is used for both PTP Master and PTP Slave ports. Class A performance is observed when different types of line cards are used for PTP Master and PTP Slave on T-BC.

### Table

<table>
<thead>
<tr>
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<th>1588/PTP</th>
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<th>Cisco IOS XR 64 bit</th>
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</table>
• G.8275.2 profile is supported on Cisco ASR 9000 Series Routers. However, the performance standards of this profile are 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.

**ITU-T Telecom Profiles for PTP**

Cisco IOS XR software supports ITU-T Telecom Profiles for PTP as defined in the ITU-T recommendation. A profile consists of PTP configuration options applicable only to a specific application.

Separate profiles can be defined to incorporate PTP in different scenarios based on the IEEE 1588-2008 standard. 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 Profile**

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 FSM 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 1 because all clocks in a 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 receive 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 Profile**

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 with SyncE 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.

**G.8275.2 Profile**

G.8275.2 profile fulfills the time-of-day and phase synchronization requirements in telecom networks with partial timing support from the network. 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 and IPv6 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.

## Configuring PTP

**Prerequisite**
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.

**PTP Interface and Profile Configuration**

When a global PTP profile is attached to an interface, its values are used as default settings for that interface. When additional settings are configured under an interface itself, these settings override the defaults in that profile. When no profile is attached to an interface, the configuration on the interface is used to determine the PTP settings for that interface.

When configuring PTP, use one of the following approaches:

- Create a profile (or multiple profiles) containing all the default settings to use on all PTP interfaces. Override any settings that differ for particular interfaces by using the interface configuration under the interfaces themselves.
- Configure all settings separately for each interface, without using any global profiles. Use this approach if the interfaces do not have consistent settings, or if you are configuring only a small number of PTP interfaces.

## Configuring Frequency Synchronization and Quality Settings for PTP

This procedure describes the steps involved to configure frequency and quality settings for PTP on a router.
1. To enable frequency synchronization on the router, use **frequency synchronization** command in the configuration mode.

   ```
   RP/0/RSP0/CPU0:router(config)# frequency synchronization
   ```

2. To configure ITU-T quality parameters, use **quality itu-t option option generation number** command in the frequency synchronization configuration mode.

   - **option 1**: Includes PRC, SSU-A, SSU-B, SEC, and DNU. This is the default option.
   - **option 2 generation 1**: Includes PRS, STU, ST2, ST3, SMC, and DUS.
   - **option 2 generation 2**: Includes PRS, STU, ST2, ST3, TNC, ST3E, SMC, and DUS.

   **Note**
   The **quality option** configured here must match the **quality option** specified in the **quality receive** and **quality transmit** commands.

   ```
   RP/0/RSP0/CPU0:router(config-freqsync)# quality itu-t option 2 generation 2
   ```

**Verification**

To display the frequency synchronization selection, use **show frequency synchronization selection** command.

   ```
   RP/0/RSP0/CPU0:router# show frequency synchronization selection
   ```

   ```
   Node 0/RSP0/CPU0:
   ================
   Selection point: T0-SEL-B (3 inputs, 1 selected)
   Last programmed 06:49:27 ago, and selection made 06:49:15 ago
   Next selection points
   SPA scoped : None
   Node scoped : T4-SEL-C 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 Sync1 [0/RSP1/CPU0] n/a PRC 1 Locked
   HundredGigE0/5/0/2 0/5/CPU0 ETH_RXMUX 1 PRC 1 Available
   Internal0 [0/RSP1/CPU0] n/a SEC 255 Available
   ```

   ```
   Selection point: T4-SEL-A (1 inputs, 1 selected)
   Last programmed 06:49:27 ago, and selection made 06:49:15 ago
   Next selection points
   SPA scoped : None
   Node scoped : T4-SEL-C
   Chassis scoped: None
   Router scoped : None
   Uses frequency selection
   S Input Last Selection Point QL Pri Status
   == ---------------------- ============ === ===========
   1 HundredGigE0/5/0/2 0/5/CPU0 ETH_RXMUX 1 PRC 1 Available
   ```

   ```
   Selection point: T4-SEL-C (2 inputs, 1 selected)
   Last programmed 06:49:15 ago, and selection made 06:49:15 ago
   ```
### System Management Configuration Guide for Cisco ASR 9000 Series Routers, IOS XR Release 6.2.x

#### Configuring Precision Time Protocol

### Configuring Frequency Synchronization and Quality Settings for PTP

**Next selection points**
- SPA scoped: None
- Node scoped: None
- Chassis scoped: None
- Router scoped: None

**Uses frequency selection**

**Used for local clock interface output**

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<th>Last Selection Point</th>
<th>QL</th>
<th>Pri</th>
<th>Status</th>
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<td>Sync1 [0/RSP1/CPU0]</td>
<td>0/RSP1/CPU0 T0-SEL-B 1 PRC 1</td>
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<td></td>
</tr>
<tr>
<td>HundredGigE0/5/0/2</td>
<td>0/RSP1/CPU0 T4-SEL-A 1 PRC 1</td>
<td>Available</td>
<td></td>
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</table>

**Selection point: CHASSIS-TOD-SEL (1 inputs, 1 selected)**
- Last programmed 6d04h ago, and selection made 6d04h ago

**Next selection points**
- SPA scoped: None
- Node scoped: None
- Chassis scoped: None
- Router scoped: None

**Uses time-of-day selection**

<table>
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<tr>
<th>S Input</th>
<th>Last Selection Point</th>
<th>Pri</th>
<th>Time</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sync1 [0/RSP1/CPU0]</td>
<td>0/RSP1/CPU0 T0-SEL-B 1</td>
<td>100</td>
<td>Yes</td>
<td>Available</td>
</tr>
</tbody>
</table>

**Node 0/3/CPU0:**

**Selection point: ETH_RXMUX (0 inputs, 0 selected)**
- Last programmed 9w6d ago, and selection made 9w6d ago

**Next selection points**
- SPA scoped: None
- Node scoped: None
- Chassis scoped: T0-SEL-B T4-SEL-A
- Router scoped: None

**Uses frequency selection**

**Selection point: LC_TX_SELECT (1 inputs, 1 selected)**
- Last programmed 9w6d ago, and selection made 9w6d 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**

<table>
<thead>
<tr>
<th>S Input</th>
<th>Last Selection Point</th>
<th>QL</th>
<th>Pri</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sync1 [0/RSP1/CPU0]</td>
<td>0/RSP1/CPU0 T0-SEL-B 1</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Node 0/5/CPU0:**

**Selection point: ETH_RXMUX (1 inputs, 1 selected)**
- Last programmed 06:49:27 ago, and selection made 06:49:27 ago

**Next selection points**
- SPA scoped: None
- Node scoped: None
- Chassis scoped: T0-SEL-B T4-SEL-A
- Router scoped: None

**Uses frequency selection**

**Selection point: LC_TX_SELECT (1 inputs, 1 selected)**
- Last programmed 6d04h ago, and selection made 6d04h ago
Configuring Global Profile

This procedure describes the steps involved to create a global configuration profile for a PTP interface that can then be assigned to any interface as required.

1. To enter the PTP configuration mode, use `ptp` command in the configuration mode.

   ```
   RP/0/RSP0/CPU0# ptp
   ```

2. To configure a PTP profile, use `profile` command in the ptp configuration mode.

   ```
   RP/0/RSP0/CPU0# profile tp64
   ```

3. To configure frequency for a Sync message for the given PTP profile, use `sync frequency rate` command in the ptp-profile configuration mode.

   ```
   RP/0/RSP0/CPU0# sync frequency 16
   ```

4. To configure delay-request frequency for the given PTP profile, use `delay-request frequency rate` command in the ptp-profile configuration mode.

   ```
   RP/0/RSP0/CPU0# delay-request frequency 16
   ```

Verification

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

```
RP/0/RSP0/CPU0# 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
transport ethernet
sync frequency 16
announce interval 1
delay-request frequency 16
!
profile master
transport ethernet
sync frequency 16
announce interval 1
```
Configuring PTP Slave Interface

This procedure describes the steps involved to configure a PTP interface to be a Slave.

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

   ```
   RP/0/RSP0/CPU0:router(config)# interface TenGigE 0/1/0/5
   ```

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

   ```
   RP/0/RSP0/CPU0:router(config-if)# ptp
   ```

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

   ```
   RP/0/RSP0/CPU0:router(config-if-ptp)# profile tp64
   ```

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

4. To configure the transport mode for all PTP messages in the given PTP profile, use `transport mode_type` command in the ptp interface configuration mode.

   ```
   RP/0/RSP0/CPU0:router(config-if-ptp)# transport ipv4
   ```

5. To configure timeout for PTP announce messages in the given PTP profile, use `announce interval interval-value` command in the ptp interface configuration mode.

   ```
   RP/0/RSP0/CPU0:router(config-if-ptp)# announce interval 1
   ```

6. To configure the port state, use `port state` command in the ptp interface configuration mode.

   ```
   RP/0/RSP0/CPU0:router(config-if-ptp)# port state slave-only
   ```

7. To configure IPv4 or IPv6 address for PTP master, use `master ipv4|ipv6 address` command in the ptp interface configuration mode.

   ```
   RP/0/RSP0/CPU0:router(config-if-ptp)# master ipv4 192.168.2.1
   ```

   ```
   RP/0/RSP0/CPU0:router(config-if-ptp)# master ipv6 2001:DB8::1
   ```

8. To return to the interface configuration mode, use `exit` command.
To configure a gateway for the given interface, use `ipv4 address address mask` command in the interface configuration mode.

```
RP/0/RSP0/CPU0:router(config-if)# ipv4 address 1.7.1.2 255.255.255.0
```

**Verification**

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

```
RP/0/RSP0/CPU0:router# show run interface TenGigE 0/1/0/5
Fri Aug 3 19:57:14.184 UTC
interface TenGigE 0/1/0/5
  ptp
  profile tp64
  transport ipv4
  port state slave-only
  master ipv4 192.168.2.1
  !
  announce interval 1
  !
  ipv4 address 1.7.1.1 255.255.255.0
```

### Configuring PTP Master Interface

This procedure describes the steps involved to configure a PTP interface to be a Master.

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

```
RP/0/RSP0/CPU0:router(config)# interface TenGigE 0/1/0/5
```

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

```
RP/0/RSP0/CPU0:router(config-if)# ptp
```

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

```
RP/0/RSP0/CPU0:router(config-if-ptp)# profile tp64
```

**Note**

Any additional commands entered in PTP interface configuration mode override settings in this profile.

```
RP/0/RSP0/CPU0:router(config-if-ptp)# profile tp64
```

4. To configure the transport mode for all PTP messages in the given PTP profile, use `transport mode_type` command in the ptp interface configuration mode.

```
RP/0/RSP0/CPU0:router(config-if-ptp)# transport ipv4
```
5. To configure timeout for PTP announce messages in the given PTP profile, use `announce interval interval-value` command in the ptp interface configuration mode.

   RP/0/RSP0/CPU0:router(config-if-ptp)# announce interval 1

6. To return to the interface configuration mode, use `exit` command.

   RP/0/RSP0/CPU0:router(config-if-ptp)# exit

7. To configure a gateway for the given interface, use `ipv4 address address mask` command in the interface configuration mode.

   RP/0/RSP0/CPU0:router(config-if)# ipv4 address 1.7.1.2 255.255.255.0

**Verification**

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

RP/0/RSP0/CPU0:router# show run interface TenGigE 0/1/0/5

Fri Aug 3 13:57:44.366 PST
interface TenGigE 0/1/0/5
   ptp
      profile tp64
      transport ipv4
      ! announcce interval 1
      ! ipv4 address 1.7.1.2 255.255.255.0

### Configuring Clock Interface for a PTP Master

This procedure describes the steps involved to configure a Clock interface for a Master.

1. To configure a clock interface, use `clock-interface sync value location node` command in the configuration mode.

   RP/0/RSP0/CPU0:router(config)# clock-interface sync 1 location 0/RSP0/CPU0

2. To configure port parameters for the given clock interface, use `port-parameters dti` command in the clock-interface configuration mode.

   RP/0/RSP0/CPU0:router(config-clock-if)# port-parameters dti

3. To enable frequency synchronization, use `frequency synchronization` command in the clock-interface configuration mode.

   RP/0/RSP0/CPU0:router(config-clock-if)# frequency synchronization

4. To configure selection input for the given clock interface, use `selection input` command in the frequency-synchronization clock-configuration mode.
RP/0/RSP0/CPU0:router(config-clk-freqsync)# selection input

5. To configure priority for the clock interface, use `priority number` command in the frequency-synchronization clock-configuration mode.

RP/0/RSP0/CPU0:router(config-clk-freqsync)# priority 1

6. To configure wait-to-restore time for the clock interface, use `wait-to-restore number` command in the frequency-synchronization clock-configuration mode.

RP/0/RSP0/CPU0:router(config-clk-freqsync)# wait-to-restore 0

7. To disable SSM packets for the clock interface, use `ssm disable` command in the frequency-synchronization clock-configuration mode.

RP/0/RSP0/CPU0:router(config-clk-freqsync)# ssm disable

8. To configure quality settings for the clock interface, use `quality receive exact itu-t option number generation number PRC` command in the frequency-synchronization clock-configuration mode.

RP/0/RSP0/CPU0:router(config-clk-freqsync)# quality receive exact itu-t option 2 generation 2 PRC

**Verification**

To display the current running configuration of an interface, use `show run clock-interface` command.

```
RP/0/RSP0/CPU0:router# show run clock-interface sync 1 location 0/RSP0/CPU0
```

clock-interface sync 1 location 0/RSP0/CPU0
port-parameters
dti
!
frequency synchronization
  selection input
  priority 1
  wait-to-restore 0
  ssm disable
  quality receive exact itu-t option 2 generation 2 PRC
!
!RP/0/RSP0/CPU0:router#

**Configuring PTP Hybrid Mode**

This procedure describes the steps involved to configure router in a hybrid mode. You can do this by selecting PTP for Time-of-Day (ToD) and another source for frequency.

1. To enable frequency synchronization on the router, use `frequency synchronization` command in the configuration mode.

```
RP/0/RSP0/CPU0:router(config)# frequency synchronization
```
2. To configure a SyncE source, create an interface to be a SyncE input. This can be configured using `interface` command in the configuration mode.

   **Note**
   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/RSP0/CPU0:router(config)# interface GigabitEthernet 0/1/0/0
   RP/0/RSP0/CPU0:router(config-if)# frequency synchronization
   RP/0/RSP0/CPU0:router(config-if-freqsync)# selection input
   RP/0/RSP0/CPU0:router(config-if-freqsync)# time-of-day-priority 100
   RP/0/RSP0/CPU0:router(config-if-freqsync)# commit
   ```

3. To configure PTP as the source for ToD, enable PTP on the router using `ptp` command in command in the configuration mode. ToD priority values can range from 1 (highest priority) to 254 (lowest priority).

   ```
   RP/0/RSP0/CPU0:router(config)# ptp
   RP/0/RSP0/CPU0:router(config-ptp)# time-of-day-priority 1
   RP/0/RSP0/CPU0:router(config)# commit
   ```

4. To configure a PTP interface, use `interface` command in configuration mode. To enable this interface as a PTP Master, use `master` command in ptp-interface configuration mode.

   ```
   RP/0/RSP0/CPU0:router(config)# interface gigabitEthernet 0/1/0/1
   RP/0/RSP0/CPU0:router(config-if)# ipv4 address 10.0.0.1/24
   RP/0/RSP0/CPU0:router(config-if)# ptp
   RP/0/RSP0/CPU0:router(config-if-tp)# master ipv4 10.0.0.2
   RP/0/RSP0/CPU0:router(config-if-tp)# commit
   ```

**Verification**

To display the frequency synchronization selection, use `show frequency synchronization selection` command.

```
RP/0/RSP0/CPU0:router# show frequency synchronization selection
Node 0/RSP1/CPU0:
------------------------
Selection point: T0-SEL-B (3 inputs, 1 selected)
   Last programmed 06:49:27 ago, and selection made 06:49:15 ago
   Next selection points
      SPA scoped : None
      Node scoped : T4-SEL-C 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 Sync1 [0/RSP1/CPU0] n/a           PRC 1 Locked
   HundredGigE0/5/0/2 0/5/CPU0 ETH_RXMUX 1 PRC 1 Available
   Interna10 [0/RSP1/CPU0] n/a                 SEC 255 Available

Selection point: T4-SEL-A (1 inputs, 1 selected)
   Last programmed 06:49:27 ago, and selection made 06:49:15 ago
```
Configuring Precision Time Protocol

Configuring PTP Hybrid Mode

Next selection points
SPA scoped : None
Node scoped : T4-SEL-C
Chassis scoped: None
Router scoped : None
Uses frequency selection

<table>
<thead>
<tr>
<th>S</th>
<th>Input</th>
<th>Last Selection Point</th>
<th>QL</th>
<th>Pri</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>HundredGigE0/5/0/2</td>
<td>0/5/CPU0 ETH_RXMUX</td>
<td>1</td>
<td>PRC</td>
<td>1</td>
</tr>
</tbody>
</table>

Selection point: T4-SEL-C (2 inputs, 1 selected)
Last programmed 06:49:15 ago, and selection made 06:49:15 ago
Next selection points
SPA scoped : None
Node scoped : None
Chassis scoped: None
Router scoped : None
Uses frequency selection
Used for local clock interface output

<table>
<thead>
<tr>
<th>S</th>
<th>Input</th>
<th>Last Selection Point</th>
<th>QL</th>
<th>Pri</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Sync1 [0/RSP1/CPU0]</td>
<td>0/RSP1/CPU0 T0-SEL-B</td>
<td>1</td>
<td>PRC</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>HundredGigE0/5/0/2</td>
<td>0/RSP1/CPU0 T4-SEL-A</td>
<td>1</td>
<td>PRC</td>
<td>1</td>
</tr>
</tbody>
</table>

Selection point: CHASSIS-TOD-SEL (1 inputs, 1 selected)
Last programmed 6d04h ago, and selection made 6d04h ago
Next selection points
SPA scoped : None
Node scoped : None
Chassis scoped: None
Router scoped : None
Uses time-of-day selection

<table>
<thead>
<tr>
<th>S</th>
<th>Input</th>
<th>Last Selection Point</th>
<th>Pri</th>
<th>Time</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Sync1 [0/RSP1/CPU0]</td>
<td>0/RSP1/CPU0 T0-SEL-B</td>
<td>100</td>
<td>Yes</td>
<td>Available</td>
</tr>
</tbody>
</table>

Node 0/0/CPU0:

Selection point: ETH_RXMUX (0 inputs, 0 selected)
Last programmed 9w6d ago, and selection made 9w6d ago
Next selection points
SPA scoped : None
Node scoped : None
Chassis scoped: T0-SEL-B T4-SEL-A
Router scoped : None
Uses frequency selection

Selection point: LC_TX_SELECT (1 inputs, 1 selected)
Last programmed 9w6d ago, and selection made 9w6d 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

<table>
<thead>
<tr>
<th>S</th>
<th>Input</th>
<th>Last Selection Point</th>
<th>QL</th>
<th>Pri</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>24</td>
<td>Sync1 [0/RSP1/CPU0]</td>
<td>0/RSP1/CPU0 T0-SEL-B</td>
<td>1</td>
<td>PRC</td>
<td>1</td>
</tr>
</tbody>
</table>

Node 0/5/CPU0:

Selection point: ETH_RXMUX (1 inputs, 1 selected)
Last programmed 06:49:27 ago, and selection made 06:49:27 ago
Configuring GPS Settings for a Grand Master Clock

This procedure describes the steps involved to configure GPS settings for a PTP Grandmaster clock.

1. To configure a clock interface, use `clock-interface sync port-number location interface-location` command in the configuration mode.

```
RP/0/RSP0/CPU0:router(config)# clock-interface sync 2 location 0/RSP0/CPU0
```

2. To configure port parameters for the given clock interface, use `port-parameters` command in the clock-interface configuration mode.

```
RP/0/RSP0/CPU0:router(config-clock-if)# port-parameters
```

3. To configure GPS input parameters, use `gps-input tod-format gprmc pps-input ttl` command.

```
RP/0/RSP0/CPU0:router(config-clk-parms)# gps-input tod-format gprmc pps-input ttl
```

4. To return to the clock-interface configuration mode, use `exit` command.

```
RP/0/RSP0/CPU0:router(config-clk-parms)# exit
```

5. To enable frequency synchronization, use `frequency synchronization` command in the clock-interface configuration mode.

```
RP/0/RSP0/CPU0:router(config-clock-if)# frequency synchronization
```

6. To configure selection input for the given clock interface, use `selection input` command in the frequency-synchronization clock-configuration mode.

```
RP/0/RSP0/CPU0:router(config-clk-freqsync)# selection input
```
7. To configure priority for the clock interface, use `priority number` command in the frequency-synchronization clock-configuration mode.

   RP/0/RSP0/CPU0:router(config-clk-freqsync)# priority 10

8. To configure wait-to-restore time for the clock interface, use `wait-to-restore number` command in the frequency-synchronization clock-configuration mode.

   RP/0/RSP0/CPU0:router(config-clk-freqsync)# wait-to-restore 0

9. To disable SSM packets for the clock interface, use `ssm disable` command in the frequency-synchronization clock-configuration mode.

   RP/0/RSP0/CPU0:router(config-clk-freqsync)# ssm disable

10. To configure quality settings for the clock interface, use `quality receive exact itu-t option number generation number PRS` command in the frequency-synchronization clock-configuration mode.

    RP/0/RSP0/CPU0:router(config-clk-freqsync)# quality receive exact itu-t option 2 generation 2 PRS

**Verification**

To verify the configured GPS parameters, use `show run clock-interface` command.

   RP/0/RSP0/CPU0:router# show run clock-interface sync 2 location 0/RSP0/CPU0

   clock-interface sync 2 location 0/RSP0/CPU0
   port-parameters
gps-input tod-format gprmc pps-input ttl

---

**Configuring PTP Telecom Profile Interface**

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

**Note**

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/RSP0/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/RSP0/CPU0:router(config-if)# ptp

3. To configure a PTP profile (or specify a previously defined profile), use `profile name` command in the ptp-interface configuration mode.
Any additional commands entered in ptp-interface configuration mode overrides the global profile settings.

4. 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/RSP0/CPU0:router(config-if-ptp)# profile tele64
   ```

   ```
   RP/0/RSP0/CPU0:router(config-if-ptp)# sync frequency 128
   ```

   ```
   RP/0/RSP0/CPU0:router(config-if-ptp)# delay-request frequency 128
   ```

5. 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.

   ```
   RP/0/RSP0/CPU0:router(config-if-ptp)# announce grant-duration 120
   ```

   ```
   RP/0/RSP0/CPU0:router(config-if-ptp)# sync grant-duration 120
   ```

   ```
   RP/0/RSP0/CPU0:router(config-if-ptp)# delay-response grant-duration 120
   ```

6. To configure a timeout value, length of time by when a PTP message must be received (before PTPS-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/RSP0/CPU0:router(config-if-ptp)# sync timeout 120
   ```

   ```
   RP/0/RSP0/CPU0:router(config-if-ptp)# delay-response timeout 120
   ```

7. 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/RSP0/CPU0:router(config-if-ptp)# unicast-grant invalid-request reduce
   ```

8. To configure IPv4 or IPv6 address for a PTP master, use `master {ipv4 | ipv6} ip-address` command in the ptp-interface configuration mode.

   ```
   RP/0/RSP0/CPU0:router(config-if-ptp)# master ipv4 192.168.2.1
   ```

   ```
   RP/0/RSP0/CPU0:router(config-if-ptp)# master ipv6 2001:db8::1
   ```
9. To override the clock-class received in Announce messages from the specified Master, use `clock-class` command in the ptp-master-interface configuration mode. The class values can range from 0 to 255.

```
RP/0/RSP0/CPU0:router(config-if-ptp-master)# clock-class 2
```

**Verification**

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

```
RP/0/RSP0/CPU0:router# show ptp interfaces brief
Fri Feb 9 11:16:45.248 UTC
<table>
<thead>
<tr>
<th>Intf</th>
<th>Port</th>
<th>Port Number</th>
<th>State</th>
<th>Encap</th>
<th>State</th>
<th>Mechanism</th>
</tr>
</thead>
<tbody>
<tr>
<td>BE1</td>
<td>1</td>
<td>Slave</td>
<td>IPv4</td>
<td>up</td>
<td>2-step DRRM</td>
<td></td>
</tr>
<tr>
<td>Gi0/0/0/40</td>
<td>2</td>
<td>Master</td>
<td>IPv4</td>
<td>up</td>
<td>2-step DRRM</td>
<td></td>
</tr>
</tbody>
</table>
```

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

```
RP/0/RSP0/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
        multicast target-address ethernet 01-1B-19-00-00-00
        transport ethernet
        port state slave-only
        clock operation two-step
    !
    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.

1. To enter the PTP configuration mode, use `ptp` command in the configuration mode.

```
RP/0/RSP0/CPU0:router(config)# ptp
```

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

```
RP/0/RSP0/CPU0:router(config-tp)# clock
```

3. 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/RSP0/CPU0:router(config-tp)# domain 24
```
4. To configure timescale, use `timescale source` command in the ptp-clock configuration mode.

   RP/0/RSP0/CPU0:router(config-ptp-clock)# timescale PTP

5. To configure the time-source that will be advertised in Announce messages, use `time-source source` command in the ptp-clock configuration mode. The allowed options are: atomic-clock, GPS, hand-set, internal-oscillator, NTP, other, PTP, and terrestrial-radio.

   RP/0/RSP0/CPU0:router(config-ptp-clock)# time-source GPS

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

   RP/0/RSP0/CPU0:router(config-ptp-clock)# exit

7. To configure the desired telecom profile and the clock type for the profile, use `clock profile { g.8265.1 | g.8275.1 | g.8275.2} clock-type {T-GM | T-BC | T-TSC}` command in the ptp configuration mode.

   RP/0/RSP0/CPU0:router(config-ptp)# clock profile g.8275.1 clock-type T-GM

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/RSP0/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/RSP0/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/RSP0/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: 1518155252.348938058 T2: 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

Configuration Examples

Slave Configuration Example

The following example shows a PTP slave configuration:

```
interface TenGigE 0/1/0/5
ptp
 profile tp64
 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 tp64
 transport ipv4
 announce interval 1
 !
 ipv4 address 1.7.1.2 255.255.255.0
 !
```
GPS Configuration Example

This example shows the GPS configuration for PTP.

clock-interface sync 2 location 0/RSP0/CPU0
  port-parameters
    gps-input tod-format gprmc pps-input ttl
  !
  frequency synchronization
  selection input
  priority 2
  wait-to-restore 0
  ssm disable
  quality receive exact itu-t option 2 generation 2 PRS
  !

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 192.168.52.38
  !
    sync frequency 64
    announce interval 1
    delay-request frequency 64
  !
interface GigabitEthernet 0/1/0/1
  ipv4 address 192.168.52.41 255.255.255.0
  speed 100
  frequency synchronization
  selection input
  priority 10
  wait-to-restore 0
  ssm disable
  time-of-day-priority 100
  !

ITU-T Telecom Profiles Configuration Examples

Master global configuration for the telecom profile:

-- For G.8265.1 profile --

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

-- For G.8275.1 profile --

ptp
clock
domain 24
profile g.8275.1
!
  profile master
transport ethernet
  sync frequency 16
  announce interval 1
  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
  clock operation two-step
!
ipv4 address 17.1.1.1/24

-- For G.8275.2 profile --

ptp
clock
domain 44
profile g.8275.2 clock-type T-GM
!
profile master
transport ipv6
  sync frequency 64
  announce frequency 8
  unicast-grant invalid-request deny
  delay-request frequency 64
!
!
interface GigabitEthernet0/2/0/11
ptp
  profile master
!
ipv6 address 30::1/64
!

Slave global configuration for the telecom profile:
-- For G.8265.1 profile --

```plaintext
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
```

-- For G.8275.1 profile --

```plaintext
ptp
  clock
domain 24
  profile g.8275.1 clock-type T-TSC
    profile slave
    transport ethernet
    sync frequency 16
    announce interval 1
    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
  clock operation two-step
  ipv4 address 18.1.1.2/24
```

-- For G.8275.2 profile --

```plaintext
ptp
  clock
domain 24
  profile g.8275.2 clock-type T-TSC
    profile slave
    transport ipv6
    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 ipv6 30::2
!
ipv6 address 30::1/64
!

Global configuration with clock type as T-Boundary Clock (T-BC) for the telecom profile:

-- For G.8265.1 profile --

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

-- For G.8275.1 profile --

ptp
clock
domain 24
profile g.8275.1 clock-type T-BC
profile master
transport ethernet
sync frequency 16
announce interval 1
delay-request frequency 16
exit
profile slave
transport ethernet
sync frequency 16
announce interval 1
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
!
clock operation two-step
!
ipv4 address 17.1.1.2/24
interface gi 0/2/0/0
ptp
profile master
transport ethernet
multicast target-address ethernet 01-1B-19-00-00-00
clock operation two-step
!
ipv4 address 18.1.1.1/24

Note When G.8275.1 profile is configured on a 100G interface, keywords commit replace and rollback config last 1 does not work and the router configuration rollback fails entirely. Use rollback config last 1 best-effort instead.

-- For G.8275.2 profile --
ptp
clock
domain 44
profile g.8275.2 clock-type T-BC
!
profile slave
transport ipv6
port state slave-only
sync frequency 64
announce frequency 8
unicast-grant invalid-request deny
delay-request frequency 64
!
profile master
transport ipv6
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
  ipv6 address 30::1/64
!
interface GigabitEthernet0/2/0/12
  ptp
  profile slave
  master ipv6 40::2
  ipv6 address 40::1/64
!
ITU-T Telecom Profiles Configuration Examples