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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, page xvii
• Obtaining Documentation and Submitting a Service Request, page xvii

Changes to this Document

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

Table 1: Changes to This Document

<table>
<thead>
<tr>
<th>Revision</th>
<th>Date</th>
<th>Change Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td>OL-30424-01</td>
<td>September 2013</td>
<td>Initial release of this document.</td>
</tr>
<tr>
<td>OL-30424-02</td>
<td>January 2014</td>
<td>Republished with documentation updates for Release 5.1.1</td>
</tr>
<tr>
<td>OL-30424-03</td>
<td>May 2014</td>
<td>Republished with documentation updates for Release 5.1.2</td>
</tr>
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</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.

- New and changed System Management features, R51, page 1

### New and changed System Management features, R51

<table>
<thead>
<tr>
<th>Feature</th>
<th>Description</th>
<th>Introduced/Changed in Release</th>
<th>Where Documented</th>
</tr>
</thead>
<tbody>
<tr>
<td>OnePK</td>
<td>This feature was introduced.</td>
<td>Release 5.1.2</td>
<td>Information About onePK, on page 261</td>
</tr>
<tr>
<td>Open Flow Agent</td>
<td>This feature was introduced.</td>
<td>Release 5.1.2</td>
<td>An overview of OFA, on page 274</td>
</tr>
<tr>
<td>Flexible CLI</td>
<td>Commands were updated/ added.</td>
<td>Release 5.1.1</td>
<td>Refer to the Cisco IOS XR System Management Command Reference.</td>
</tr>
<tr>
<td>4arg</td>
<td>This feature was introduced.</td>
<td>Release 5.1</td>
<td>4arg, on page 385</td>
</tr>
<tr>
<td>SNMP updates</td>
<td>This feature was modified.</td>
<td>Release 5.1</td>
<td>Session MIB support on subscriber sessions, on page 363</td>
</tr>
</tbody>
</table>
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.</td>
</tr>
<tr>
<td></td>
<td>The feature profile was introduced.</td>
</tr>
</tbody>
</table>

This model contains the following topics:

- Restrictions of Scale Profiles, page 3
- Information About Profiles, page 4
- How to Configure Profiles, page 5
- Additional References, 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 3: Interaction between Scale and Feature Profiles**

<table>
<thead>
<tr>
<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(^1) scale</td>
</tr>
<tr>
<td>Layer 3 Scale Profile</td>
<td>Up to 1.0 M Layer 3 CEF scale</td>
</tr>
<tr>
<td></td>
<td>Less than 128 K MAC entries</td>
</tr>
<tr>
<td>Layer 3 XL Scale Profile</td>
<td>Up to 1.3 M Layer 3 CEF scale</td>
</tr>
</tbody>
</table>

\(^1\) Cisco Express Forwarding
\(^2\) 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>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>RP/0/RSP0/CPU0:router# admin</td>
</tr>
<tr>
<td>Step 2</td>
<td>configure</td>
<td>Enters administration configuration mode.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
<td>RP/0/RSP0/CPU0:router(admin)# configure</td>
</tr>
<tr>
<td>Step 3</td>
<td>hw-module profile scale {default</td>
<td>l3</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
<td>RP/0/RSP0/CPU0:router(admin-config)# hw-module profile scale l3xl</td>
</tr>
<tr>
<td>Sun Nov 14 10:04:27.109 PST</td>
<td>In order to activate this new memory resource profile, you must manually reboot the system.</td>
<td></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
Configuring Profiles

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.

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Functionality</strong></td>
<td>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.</td>
</tr>
</tbody>
</table>

**Step 4**

commit

**Step 5**

reload location all

Example:

RP/0/RSP0/CPU0:router@admin)# reload location all

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.

**Step 6**

show running-config

Example:

RP/0/RSP0/CPU0:router@admin)# show running-config hw-module profile scale

Displays the configured scale profile.

**Step 7**

show hw-module profile

Example:

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

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.

---

### 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>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1</td>
<td><strong>admin</strong></td>
<td>Enters administration EXEC mode.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>RP/0/RSP0/CPU0:router# admin</td>
<td></td>
</tr>
<tr>
<td>Step 2</td>
<td><strong>configure</strong></td>
<td>Enters administration configuration mode.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>RP/0/RSP0/CPU0:router(admin)# configure</td>
<td></td>
</tr>
<tr>
<td>Step 3</td>
<td><strong>hw-module profile feature</strong> {default</td>
<td>l2}</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>RP/0/RSP0/CPU0:router(admin-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></td>
<td>• l2—supports PBB, but does not support IPv6, reverse-path forwarding (RPF) and netflow.</td>
</tr>
<tr>
<td>Step 4</td>
<td><strong>commit</strong></td>
<td></td>
</tr>
<tr>
<td>Step 5</td>
<td><strong>reload location</strong> {all</td>
<td>node-id}</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>RP/0/RSP0/CPU0:router(admin)# reload location 0/0/cpu0</td>
<td></td>
</tr>
<tr>
<td>Step 6</td>
<td><strong>show running-config</strong></td>
<td>Displays the configured feature profile.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>RP/0/RSP0/CPU0:router(admin)# show running-config hw-module profile feature</td>
<td></td>
</tr>
<tr>
<td>Step 7</td>
<td><strong>show hw-module profile feature</strong></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><strong>Example:</strong></td>
<td>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 : prm_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.

LC/0/1/CPU0:Nov 5 02:50:42.732 : prm_server[236]: Active 'hw-module profile feature l2' does not support IPv6, RPF, or Netflow features. Please remove all unsupported feature configurations.

"hw-module profile feature" syntax only applies to Trident based line cards; therefore the limitations of IPv6, reverse-path forwarding (RPF) and Netflow do not apply to either Tomahawk or Typhoon based line cards.

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>Step 1</td>
<td>show running-config</td>
</tr>
<tr>
<td>Example:</td>
<td>RP/0/RSP0/CPU0:router# show running-config</td>
</tr>
<tr>
<td></td>
<td>Copies the contents of the running configuration to a file.</td>
</tr>
</tbody>
</table>
### Purpose

**Command or Action**

**Step 2**

Remove the line with the command `hw-module profile scale` from the file created in the previous step.

**Step 3**

configure

**Step 4**

load new-config-file

**Example:**

```
RP/0/RSP0/CPU0:router(config)# load new-config-file
```

**Step 5**

commit replace

**Example:**

```
RP/0/RSP0/CPU0:router(config)# commit replace
```

### Additional References

#### Related Documents

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

#### Standards and RFCs

<table>
<thead>
<tr>
<th>Standard/RFC</th>
<th>Title</th>
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</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>

---

**Cisco ASR 9000 Series Aggregation Services Router System Management Configuration Guide, Release 5.1.x**
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. 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. 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>
Secure Domain Routers on the Cisco ASR 9000 Series Router

Secure domain routers (SDRs) are a means of dividing a single physical system into multiple logically separated routers. Cisco ASR 9000 Series Routers are single-shelf routers that only support one SDR—the owner SDR.

Table 4: Feature History for Secure Domain Routers 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>
</tbody>
</table>

This module contains the following topics:

- Prerequisites for Working with Secure Domain Routers, page 13
- Information About Configuring Secure Domain Routers, page 14
- Additional References, page 17

Prerequisites for Working with Secure Domain Routers

Initial Setup

- The router must be running the Cisco IOS XR software.
- The root-system username and password must be assigned as part of the initial configuration.
- For more information on booting a router and performing initial configuration, see Cisco ASR 9000 Series Aggregation Services Router Getting Started Guide.

Required Cards for Each SDR

- Route switch processor (RSP) pair must be installed for the SDR.
Task ID Requirements

- 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.

Maximum SDR Configurations

- Only one owner SDR is supported. Non-owner SDRs are not supported

Information About Configuring Secure Domain Routers

What Is a Secure Domain Router?

Cisco routers running the Cisco IOS XR software can be partitioned into multiple independent routers known as Secure Domain Routers (SDRs). An user defined SDR is termed as named-SDR.

SDRs are a means of dividing a single physical system into multiple logically separated routers. The SDRs are spawned as Virtual Machines (VMs). Each SDR performs routing functions similar to a physical router, but they share resources with the rest of the system. For example, the software image, configurations, protocols, and routing tables are unique to a particular SDR. Other system functions, including chassis-control and switch fabric, are shared with the rest of the system.

Note

Cisco ASR 9000 Series Routers are single-shelf routers that only support one SDR—the owner SDR.

Owner SDR and Administration Configuration Mode

The owner SDR is created at system startup and cannot be removed. This owner SDR performs system-wide functions, including the creation of additional non-owner SDRs. You cannot create the owner SDR because it always exists, nor can you completely remove the owner SDR because it is necessary to manage the router. By default, all nodes in the system belong to the owner SDR.

The owner SDR also provides access to the administration EXEC and administration configuration modes. Only users with root-system privileges can access the administration modes by logging in to the primary route switch processor (RSP) for the owner SDR (called the designated shelf controller, or DSC).

Administration modes are used to view and manage system-wide resources and logs.

Related Topics

SDR Access Privileges, on page 14

SDR Access Privileges

Each SDR in a router has a separate AAA configuration that defines usernames, passwords, and associated privileges.
• Only users with root-system privileges can access the administration EXEC and administration configuration modes.

• Users with other access privileges can access features according to their assigned privileges for a specific SDR.

For more information about AAA policies, see the Configuring AAA Services on the Cisco ASR 9000 Series Router module of Cisco ASR 9000 Series Aggregation Services Router System Security Configuration Guide.

Related Topics
Root-System Users, on page 15
root-lr Users, on page 15
Other SDR Users, on page 16

Root-System Users

Users with root-system privileges have access to system-wide features and resources. The root-system user is created during the initial boot and configuration of the router.

The root-system user has the following privileges:

• Access to administration EXEC and administration configuration commands.

• Ability to create other users with similar or lower privileges.

• Complete authority over the chassis.

• Ability to install and activate software packages for the router.

• Ability to view the following administration (admin) plane events (owner SDR logging system only):
  ◦ Software installation operations and events.
  ◦ System card boot operations, such as card booting notifications and errors, heartbeat-missed notifications, and card reloads.
  ◦ Card alphanumeric display changes.
  ◦ Environment monitoring events and alarms.
  ◦ Fabric control events.
  ◦ Upgrade progress information.

root-lr Users

Users with root-lr privileges can log in to an SDR only and perform configuration tasks that are specific to that SDR. The root-lr group has the following privileges:

• Ability to configure interfaces and protocols.

• Ability to create other users with similar or lower privileges on the SDR.

• Ability to view the resources assigned to their particular SDR.

The following restrictions apply to root-lr users:
- Users with root-lr privileges cannot enter administration EXEC or configuration modes.
- Users with root-lr privileges cannot add or remove nodes from an SDR.
- Users with root-lr privileges cannot create root-system users.
- The highest privilege a non-owner SDR user can have is root-lr.

**Other SDR Users**

Additional usernames and passwords can be created by the root-system or root-lr users to provide more restricted access to the configuration and management capabilities of the owner SDR.

**Designated Shelf Controller (DSC)**

In a router running Cisco IOS XR software, one RSP is assigned the role of DSC. The DSC provides system-wide administration and control capability, including access to the administration EXEC and administration configuration modes. For more information on DSCs, refer to *Cisco ASR 9000 Series Aggregation Services Router Getting Started Guide*.

**Default Configuration of the Router**

When a router is brought up, the nodes assigned to the router are activated with the default software package profile. In Cisco IOS XR software, the default software profile is defined by the last install operation.

To view the default software profile, use the `show install active summary` command in administration EXEC mode. Any new nodes that are configured to the router boot with the default software profile listed in the output of this command.

```
RP/0/RSP0/CPU0:router# show install active summary

Tue Jul 21 06:10:48.321 DST
Active Packages:
  disk0:comp-asr9k-mini-3.9.0.14I
  disk0:asr9k-adv-video-3.9.0.14I
  disk0:asr9k-fpd-3.9.0.14I
  disk0:asr9k-k9sec-3.9.0.14I
  disk0:asr9k-mgbl-3.9.0.14I
  disk0:asr9k-mcast-3.9.0.14I
  disk0:asr9k-mpls-3.9.0.14I
```

For detailed instructions to add and activate software packages, see the *Upgrading and Managing Cisco IOS XR Software* module of the *Cisco ASR 9000 Series Aggregation Services Router System Management Configuration Guide*. See also the *Software Package Management Commands on Cisco IOS XR Software* module of the *Cisco ASR 9000 Series Aggregation Services Router System Management Command Reference*.

**Cisco IOS XR Software Package Management**

Software packages are added to the DSC of the system from administration EXEC mode. Once added, a package can be activated for the system. For detailed instructions regarding software package management,
see the *Upgrading and Managing Cisco IOS XR Software* module of *Cisco ASR 9000 Series Aggregation Services Router System Management Configuration Guide*. See also the Software Package Management Commands on the Cisco ASR 9000 Series Router module of *Cisco ASR 9000 Series Aggregation Services Router System Management Command Reference*.

- To access `install` commands, you must be a member of the root-system user group with access to the administration EXEC mode.
- Most `show install` commands can be used in the EXEC mode of an SDR to view the details of the active packages for that SDR.

**Related Topics**

Default Configuration of the Router, on page 16

---

**Additional References**

The following sections provide references related to SDR 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><em>Cisco ASR 9000 Series Aggregation Services Router Getting Started Guide</em></td>
</tr>
<tr>
<td>Cisco IOS XR master command reference</td>
<td><em>Cisco ASR 9000 Series Aggregation Services Router Commands Master List</em></td>
</tr>
<tr>
<td>Information about user groups and task IDs</td>
<td><em>Configuring AAA Services on the Cisco ASR 9000 Series Router</em> module of <em>Cisco ASR 9000 Series Aggregation Services Router System Security Configuration Guide</em></td>
</tr>
<tr>
<td>Cisco IOS XR interface configuration commands</td>
<td><em>Cisco ASR 9000 Series Aggregation Services Router Interface and Hardware Component Command Reference</em></td>
</tr>
<tr>
<td>Information about AAA policies, including instructions to create and modify users and username access privileges</td>
<td><em>Configuring AAA Services on the Cisco ASR 9000 Series Router</em> module of <em>Cisco ASR 9000 Series Aggregation Services Router System Security Configuration Guide</em></td>
</tr>
</tbody>
</table>

**Standards**

<table>
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<th>Title</th>
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</table>

**RFCs**

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<tr>
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**Technical Assistance**

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<tr>
<th>Description</th>
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</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 72. 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 5: 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 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 58. Support for installation commands was removed from EXEC mode. The ability to install software on a specific SDR was removed.</td>
</tr>
</tbody>
</table>

This module contains the following topics:

- Overview of Cisco IOS XR Software Packages, page 20
- Information About Package Management, page 25
- Package Management Procedures, page 34
- Rolling Back to a Previous Software Set, page 69
- Additional References, page 72
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.

---

**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).

---

**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 *Cisco ASR 9000 Series Aggregation Services Router ROM Monitor Guide*.
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

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

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 6: PIE Filenames, on page 22 shows the filenames for available PIE types.

**Table 6: 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><code>platform-composite_name.pie-major.minor.maint</code></td>
<td><code>asr9k-mini.pie-3.7.2</code></td>
</tr>
<tr>
<td>Single package PIE</td>
<td><code>platform-package_type.-p.pie-major.minor.maint</code></td>
<td><code>asr9k-mpls.pie-3.7.2</code></td>
</tr>
<tr>
<td>Composite SMU</td>
<td><code>platform-p.composite_name.ddts.pie</code></td>
<td><code>asr9k-p-4.0.0.16C.CS10c98xxx.pie</code></td>
</tr>
</tbody>
</table>

**Filename Component Description**

The filename components for all packages are described in Table 7: Composite- and Single-Package Filename Components, on page 22.

**Table 7: Composite- and Single-Package Filename Components**

<table>
<thead>
<tr>
<th>Component</th>
<th>Description</th>
</tr>
</thead>
</table>
| `platform`             | Identifies the platform for which the software package is designed.  
                          | • The platform designation is "asr9k."                                                                                                     |
| `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. |
### Component: 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

### Component: 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.

### Component: 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.
<table>
<thead>
<tr>
<th>Component</th>
<th>Description</th>
</tr>
</thead>
</table>
| **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\(^3\) 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. |
| p | In Cisco IOS XR Software Release 4.0, the software packages were reorganized into functionally well-defined and independently-releasable packages that support the hardware with the PPC architecture. These reorganized packages are identified by the -p in the filename. These packages are not compatible with packages released prior to Release 4.0. When upgrading to Release 4.0 or above, special upgrade instructions must be followed. |
| px | Identifies images that are compatible with hardware that uses the x86 architecture. Starting with Cisco IOS XR Release 4.2, -px releases replace the -p releases. |

\(^3\) distributed defect tracking system

**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 recommended 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:. 
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 1: Process to Add, Activate, and Commit Cisco IOS XR Software Packages, on page 25 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:) of your router.

From administration EXEC mode, the package software files are added to the boot device of the DSC of the router, as well as all active and standby Route Processors (RPs) and fabric shelf controllers (SCs) installed on the router.
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 *Cisco ASR 9000 Series Aggregation Services Router ROM Monitor Guide*. 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/O/RSP0/CPU0: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,
        NP24-4x10GE,
        NP24-40x1GE, NP40-40x1GE, NP40-4x10GE, NP40-8x10GE, NP40-2_20_COMBO, NP80-8x10GE,
        NP80-16x10GE, NP200-24x10GE, NP200-36x10GE, NP200-2x100GE, NP200-1x100GE,
        NP200-5x40GE,
        NP200-8x10GE, NP200-MOD-SMEM, NP200-MOD-LMEM, ASR9001-LC, A9K-SIP-700,
        A9K-SIP-500, A9K-SIP-AVSM
    Restart information:
      Default:
        parallel impacted processes restart
    Size Compressed/Uncompressed: 1744KB/1830KB (95%)
    Components in package disk0:asr9k-px-4.x.x.04I.CSCuc66088-0.0.4.i, package
    asr9k-px-4.x.x.04I.CSCuc66088:
      disk0:iosxr-infra-4.x.x.04I.CSCuc66088-0.0.4.i
        iosxr-infra-4.x.x.04I.CSCuc66088 V0.0.4.i[SMU] IOS-XR Infra Package Definition
        Vendor : Cisco Systems
        Desc : IOS-XR Infra Package Definition
        Build : Built on Fri Nov 9 11:00:10 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,
            NP24-4x10GE,
            NP24-40x1GE, NP40-40x1GE, NP40-4x10GE, NP40-8x10GE, NP40-2_20_COMBO, NP80-8x10GE,
            NP80-16x10GE, NP200-24x10GE, NP200-36x10GE, NP200-2x100GE, NP200-1x100GE,
            NP200-5x40GE,
            NP200-8x10GE, NP200-MOD-SMEM, NP200-MOD-LMEM, ASR9001-LC, A9K-SIP-700,
            A9K-SIP-500, A9K-SIP-AVSM
    Size Compressed/Uncompressed: 1744KB/1830KB (95%)
    Components in package disk0:iosxr-infra-4.x.x.04I.CSCuc66088-0.0.4.i, package
    iosxr-infra-4.x.x.04I.CSCuc66088:
      platforms-spa-chopper V[ci-4x-bugfix/8] This component contains Platform Independent
        Chopper SPA Code.
        iosxr-infra-4.x.x.04I.CSCuc66088-package V[Default] Manifest information for
```
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.

Activating a Package on the Router

To activate a package on your router, use the `install activate` command 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.

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 from administration EXEC mode.

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.
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 in administration EXEC mode. On startup, the designated shelf controller (DSC) of the secure domain router (SDR) loads the committed software set.

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](#)

### 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 superseded 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 superseded by SMU B. In this case, SMU A is redundant and can be deactivated to clean up the software package.

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

```
RP/0/RSP0/CPU0: router (admin) # install deactivate superseded
```

To display the details of the SMUs that are superseded, use the `show install superseded` command in the EXEC mode.

```
RP/0/RSP0/CPU0: 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/CPU0: 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 2: Example of a Maintenance Release Package Upgrade, on page 30). 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.

Figure 2: Example of a Maintenance Release Package Upgrade

<table>
<thead>
<tr>
<th>Old Package</th>
<th>New Package</th>
</tr>
</thead>
<tbody>
<tr>
<td>MPLS 2.0.0</td>
<td>MPLS 2.0.0</td>
</tr>
<tr>
<td>Routing 2.0.0</td>
<td>Routing 2.0.1</td>
</tr>
<tr>
<td>Forwarding 2.0.0</td>
<td>Forwarding 2.0.0</td>
</tr>
<tr>
<td>Base 2.0.0</td>
<td>Base 2.0.0</td>
</tr>
</tbody>
</table>

Related Topics

Deactivating and Removing Cisco IOS XR Software Packages, on page 64

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 64
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 22
Obtaining and Placing Cisco IOS XR Software, on page 35

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.

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.
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).

---

**Tip**

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
```
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

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
install activate disk0:asr9k-mcast-3.7.2.1I
install activate disk0:asr9k-mgbl-3.7.2.1I
install activate 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-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 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-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)
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 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 2 completed successfully at 18:07:48 UTC Sat Jun 03 2006.

---

Package Management Procedures

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

Related Topics

Information About Package Management, on page 25

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 Cisco ASR 9000 Series Aggregation Services Router ROM Monitor Guide.

• 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]: %MGBL-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.

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 8: Download Protocols Supported by Cisco IOS XR Software**, on page 36 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 8: Download Protocols Supported by Cisco IOS XR Software**

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
</table>
| Trivial File Transfer Protocol | 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. | Note
|                             | 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. |
| File Transfer Protocol      | FTP is part of the TCP/IP protocol stack and requires a username and password. |
| Remote Copy Protocol        | The rcp protocol uses TCP to ensure the reliable delivery of data, and rcp downloads require a usernames. |
| SSH File Transfer Protocol  | SFTP is part of the SSHv2 feature in the Security package and provides for secure file transfers. For more information, see the Cisco ASR 9000 Series Aggregation Services Router System Security Configuration Guide. |
The router commands listed in Table 9: Commands for Copying Package Files to the Router, on page 37 show how to copy package files to the router using three types of file transfer protocols.

**Table 9: Commands for Copying Package Files to the Router**

<table>
<thead>
<tr>
<th>Server Type</th>
<th>Command and Examples</th>
</tr>
</thead>
</table>
| TFTP        | The following command syntax is used:  
  `copy tftp://hostname_or_ipaddress/directory-path/pie-name disk1:`  
  Example:  
  `RP/0/RSP0/CPU0:router# copy tftp://10.1.1.1/images/comp-asr9k-mini.pie disk1:` |
| FTP         | The following command syntax is used:  
  `copy ftp://username:password@hostname_or_ipaddress/directory-path/pie-name disk1:`  
  Example:  
  `RP/0/RSP0/CPU0:router# copy ftp://john:secret@10.1.1.1/images/comp-asr9k-mini.pie disk1:` |
| rcp         | 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 10: Command Variables for Copying and Adding Packages from a Network Server, on page 37 describes the command variables for copying packages from a network server.

**Table 10: Command Variables for Copying and Adding Packages from a Network Server**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>hostname_or_ipaddress</code></td>
<td>Host name or IP address of the server that stores the source file.</td>
</tr>
<tr>
<td><code>pie-name</code></td>
<td>Name of the PIE file (package). See the Overview of Cisco IOS XR Software Packages, on page 20 for descriptions of the available packages.</td>
</tr>
<tr>
<td><code>username</code></td>
<td>Required for FTP and rcp only and must be a valid username on the FTP or rcp server.</td>
</tr>
</tbody>
</table>
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 *Cisco ASR 9000 Series Aggregation Services Router ROM Monitor Guide* for information on installing from *vm* files.

**Related Topics**

- Adding and Activating Packages, on page 48
- Overview of Cisco IOS XR Software Packages, on page 20

### 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>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>
<tr>
<td>RP/0/RSP0/CPU0:router# admin</td>
<td></td>
</tr>
<tr>
<td><strong>Step 2</strong> show diag</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>
</tr>
<tr>
<td>RP/0/RSP0/CPU0:router(admin)# show diag</td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong> Update the ROMMON software if necessary.</td>
<td>Updates the ROMMON software. For instructions, see Cisco ASR 9000 Series Aggregation Services Router ROM Monitor Guide.</td>
</tr>
<tr>
<td><strong>Step 4</strong> show install active</td>
<td>Displays the active software on the router 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>Example:</td>
<td></td>
</tr>
<tr>
<td>RP/0/RSP0/CPU0:router(admin)# show install active</td>
<td>You can also display the active packages for a specific node, and view results in detailed or summary mode. See the Software Package Management Commands on the Cisco ASR 9000 Series Router module of Cisco ASR 9000 Series Aggregation Services Router System Management Command Reference for more information.</td>
</tr>
<tr>
<td>Command or Action</td>
<td>Purpose</td>
</tr>
<tr>
<td>-----------------------------------------</td>
<td>---------</td>
</tr>
<tr>
<td><strong>Step 5</strong> show install pie-info device:package [ brief</td>
<td>detail</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>RP/0/RSP0/CPU0:router (admin)#</td>
<td></td>
</tr>
<tr>
<td>show install pie-info</td>
<td></td>
</tr>
<tr>
<td>disk1:/asr9k-mcast-p.pie-3.8.30</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Step 6</strong> 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>Example:</td>
<td></td>
</tr>
<tr>
<td>RP/0/RSP0/CPU0:router (admin)#</td>
<td></td>
</tr>
<tr>
<td>install verify packages</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Step 7</strong> exit</td>
<td>Exits administration EXEC mode and returns to 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>exit</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Step 8</strong> show system verify start</td>
<td>(Optional) Starts the system status check.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>RP/0/RSP0/CPU0:router#</td>
<td></td>
</tr>
<tr>
<td>show system verify start</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Step 9</strong> show system verify [ detail</td>
<td>(Optional) 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.</td>
</tr>
<tr>
<td>report ]</td>
<td></td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>RP/0/RSP0/CPU0:router#</td>
<td></td>
</tr>
<tr>
<td>show system verify</td>
<td></td>
</tr>
<tr>
<td>• detail—Displays additional information at the card and processor level, including actual numbers.</td>
<td></td>
</tr>
<tr>
<td>• report—Displays the same information as the default show system verify command</td>
<td></td>
</tr>
</tbody>
</table>
Purpose

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.

Note

Verifies that the system clock is correct. Software operations use certificates based on router clock times.

Step 10

**show clock**

Example:

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

**Note**

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 *Cisco ASR 9000 Series Aggregation Services Router ROM Monitor Guide*.

```
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: 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/CLPLD/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
EOBSSwitch : 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: 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 : V0.0
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: V1D
HwRev: V0.0
New Deviation Number: 0
CLEI: 1P33AE0CAA
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 0x2020b
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
PHY4: V0.16
PHY5: V0.16
PHY6: V0.16
PHY7: V0.16
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
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.

Note

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.

```
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]
  meta-data: [SUCCESS] Verification Successful.
  /install/asr9k-acfclient-3.9.0.12I: [SUCCESS] Verification Successful.
  /install/asr9k-k-diags-3.9.0.12I: [SUCCESS] Verification Successful.
  /install/asr9k-admin-3.9.0.12I: [SUCCESS] Verification Successful.
Info: Successful.
```
Info: 0/1/CPU0 [LC] [SDR: Owner]
Info: meta-data: [SUCCESS] Verification Successful.
Info: 0/4/CPU0 [LC] [SDR: Owner]
Info: meta-data: [SUCCESS] Verification Successful.
Info: 0/RSP0/CPU0 [RP] [SDR: Owner]
Info: meta-data: [SUCCESS] Verification 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 the system.
Verifying the Current System Status: Example

The following example shows how to prepare for system verification:

```
RP/0/RSP0/CPUD: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/CPUD:router# show system verify
Getting current router status ...
System Verification Report
-------------------------------
- Verifying Memory Usage       : [OK]
- Verified Memory Usage        : [OK]
- Verifying CPU Usage          : [OK]
- Verified CPU Usage           : [OK]
- Verifying Blocked Processes  : [OK]
- Verified Blocked Processes   : [OK]
- Verifying Aborted Processes  : [OK]
- Verified Aborted Processes   : [OK]
- Verifying Crashed Processes  : [OK]
- Verified Crashed Processes   : [OK]
- Verifying LC Status          : [OK]
- Verified LC Status           : [OK]
- Verifying QNET Status        : [FAIL]
Unable to get current LC status info
- Verified QNET Status         : [FAIL]
- Verifying GSP Fabric Status  : [OK]
- Verified GSP Fabric Status   : [OK]
- Verifying GSP Ethernet Status: [OK]
gp WARNING messages for router
Current set of gp ping nodes does not match initial set of nodes
- Verified GSP Ethernet Status : [WARNING]
- Verifying POS interface Status: [OK]
- Verified POS interface Status: [OK]
- Verifying TenGigE interface Status: [OK]
- Verified TenGigE interface Status: [OK]
- Verifying TCP statistics    : [OK]
- Verified TCP statistics     : [OK]
- Verifying UDP statistics    : [OK]
tcp_udp_raw WARNING messages for router
UDP Packets sent has not increased during this period.
- Verified UDP statistics     : [WARNING]
- Verified RAW statistics     : [OK]
- Verified RAW statistics     : [OK]
- Verifying RIB Status        : [OK]
- Verified RIB Status         : [OK]
- Verifying CEF Status        : [OK]
- Verified CEF Status         : [OK]
- Verifying CEF Consistency Status: [OK]
- Verified CEF Consistency Status: [OK]
- Verifying BGP Status        : [OK]
```
- 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.

**Note**

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.

**Note**

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 Cisco ASR 9000 Series Aggregation Services Router ROM Monitor Guide.

- 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 38 section.

**Note** 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] [prompt-level {all | none}] [auto-abort-timer {time | off}]`
7. Repeat Step 4, on page 50 through Step 6, on page 51 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>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> 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>
</tbody>
</table>
## Adding and Activating Packages

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 2</strong></td>
<td>dir flash-disk: (Optional) Displays the package files that are available for package upgrades and additions.</td>
</tr>
<tr>
<td><strong>Step 3</strong></td>
<td>admin Enters administration EXEC mode.</td>
</tr>
<tr>
<td><strong>Step 4</strong></td>
<td>install add [source source-path</td>
</tr>
</tbody>
</table>

### Example:

**Example:**

RP/0/RSP0/CPU0:router# dir disk1:

**Note** Only PIE files can be added and activated using this procedure.

**Note** Some **show install** commands can be entered in EXEC mode on an SDR.

<table>
<thead>
<tr>
<th>Example:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>RP/0/RSP0/CPU0:router# dir disk1:</td>
<td></td>
</tr>
<tr>
<td>RP/0/RSP0/CPU0:router# admin</td>
<td></td>
</tr>
<tr>
<td>RP/0/RSP0/CPU0:router# install add disk1:asr9k-mgbl.pie-3.8.30.11</td>
<td></td>
</tr>
<tr>
<td>or</td>
<td></td>
</tr>
<tr>
<td>RP/0/RSP0/CPU0:router# install add source tftp://10.1.1.1/images/ asr9k-k9sec-p.pie asr9k-mpls-p.pie asr9k-mcast-p.pie</td>
<td></td>
</tr>
<tr>
<td>or</td>
<td></td>
</tr>
<tr>
<td>RP/0/RSP0/CPU0:router# install add source ftp://john:secret@10.1.1.1/images/asr9k-k9sec-p.pie</td>
<td></td>
</tr>
<tr>
<td>or</td>
<td></td>
</tr>
<tr>
<td>RP/0/RSP0/CPU0:router# install add tar rcp://john@10.1.1.1/images/asr9k-iosxr-3.6.0.tar</td>
<td></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 of a tar file containing one or more PIE files, or directories containing PIE files.

- **tftp://**—Unpacks the PIE file from a network server using Trivial File Transfer Protocol.

- **ftp://**—Unpacks the PIE file from a network server using File Transfer Protocol.

- **rcp://**—Unpacks the PIE file from a network server using Remote Copy Protocol.
### Purpose
- **hostname_or_ipaddress**—Host name or IP address of the network file server.
- **directory-path**—Network file server path that leads to the PIE file to be added.
- **username**—Username of user that has access privileges to the directory in which the PIE file is stored.
- **password**—Password associated with the username of user that has access privileges to the directory in which the PIE file is stored.
- **activate**—Automatically activates the software package after it is successfully added.

**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.

### Command or Action

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

### Step 5
**show install inactive summary**

**Example:**
```
RP/0/RSP0/CPU0:router# show install inactive summary
```
(Optional) 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] [prompt-level {all | none}] [auto-abort-timer {time | off}]**

**Example:**
```
RP/0/RSP0/CPU0:router# 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 of the boot device and inactive package, which can be displayed as described in the previous step.

**Note**
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.

- **location node-id**—Activates a package for a specific card (node). To display a list of node IDs for the entire system, enter the `show platform` command in administration EXEC mode. A package cannot be activated on a single card.
<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>node unless some version of the package being activated is already active on all nodes.</td>
</tr>
<tr>
<td></td>
<td><strong>Note</strong> By default, packages are activated for all cards supported by that package.</td>
</tr>
<tr>
<td></td>
<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>
</tr>
<tr>
<td></td>
<td>• <strong>prompt-level</strong>—Use a prompt-level of all to view all stages of the installation process and to specify whether to continue, or not.</td>
</tr>
<tr>
<td></td>
<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 <strong>install commit</strong> command to cancel the timer and commit the new loadpath.</td>
</tr>
<tr>
<td></td>
<td><strong>Note</strong> 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></td>
<td><strong>Tip</strong> When activating packages, 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.</td>
</tr>
<tr>
<td></td>
<td><strong>Tip</strong> The automatic FPD upgrade occurs only when the FPD pie is added and activated together with the install PIE.</td>
</tr>
</tbody>
</table>

**Step 7** Repeat **Step 4, on page 50** through **Step 6, on page 51** until all packages are activated.

Activates additional packages as required.

**Step 8** **show install active summary**

**Example:**

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

(Optional) Displays all active packages. Use this display to determine if the correct packages are active.
<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
</table>
| **Step 9** install verify packages | (Optional) 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.  
  **Note** The `install verify packages` command can take up to two minutes for each package to process. |
| **Step 10** exit          | (Optional) Exits administration EXEC mode and returns to EXEC mode.     |
| **Step 11** show system verify start | (Optional) Starts the system status check.                              |
| **Step 12** admin         | Enters administration EXEC mode.                                        |
| **Step 13** install commit | (Optional) Commits the current set of packages on the router so that these packages are used if the router is restarted.  
  For more information, see the Related Topics section. |
| **Step 14** Upgrade the field-programmable device (FPD) software, if necessary. | 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. |
Adding and Activating Packages

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>For information on FPDs, including instructions to upgrade FPD images, see the <em>Upgrading FPD Cisco IOS XR Software</em> section.</td>
</tr>
</tbody>
</table>

**Related Topics**

- Obtaining and Placing Cisco IOS XR Software, on page 35
- Activation and Deactivation Prerequisites, on page 34
- Preparing for Software Installation Operations, on page 38
- Information About Package Management, on page 25
- Downgrading Packages, on page 30
- PIE Filenames and Version Numbers, on page 22
- Committing the Active Package Set, on page 56
- 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.

```
RP/0/RSP0/CPU0:router (admin) # install add disk1:asr9k-mpls-p.pie-3.7.2 synchronous
```

```
Install operation 4 'install add /disk1:asr9k 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-3.7.2
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
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 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 '(admin) 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
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
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-p.pie-3.7.2 activate

Install operation 4 'install add /disk1:asr9k-mgbl-3.7.2 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-3.7.2
Info: 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
Info: commit' to make changes persistent.
Info: Please verify that the system is consistent following the software change using the following commands:

- show system verify
- 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
```

Comitting 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>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>Example:</td>
<td>RP/0/RSP0/CPU0:router# admin</td>
</tr>
<tr>
<td></td>
<td>Enters administration EXEC mode.</td>
</tr>
<tr>
<td><strong>Step 2</strong></td>
<td><strong>install commit</strong></td>
</tr>
<tr>
<td>Example:</td>
<td>RP/0/RSP0/CPU0:router{admin}# install commit</td>
</tr>
<tr>
<td></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><strong>Step 3</strong></td>
<td>**show install committed [detail</td>
</tr>
<tr>
<td>Example:</td>
<td>RP/0/RSP0/CPU0:router{admin}# show install committed</td>
</tr>
<tr>
<td></td>
<td>Displays which packages are committed.</td>
</tr>
</tbody>
</table>

### 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-mpls-3.9.0.12I

Node 0/4/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-mpls-3.9.0.12I

Node 0/6/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-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

In Cisco IOS XR Software Release 4.0, the software packages were reorganized into functionally well-defined and independently-releasable packages. For this reason, when you upgrade from a software release prior to Release 4.0, you must perform the following procedure in order to synchronize all of the software packages according to the reorganized structure. General information regarding the addition and activation of software packages is not covered in this procedure.

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, see the adding and activating software package procedures described in this module.

### 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><strong>admin</strong></td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>RP/0/RSP0/CPU0:router# admin</td>
</tr>
<tr>
<td></td>
<td>Enters administration EXEC mode.</td>
</tr>
<tr>
<td><strong>Step 2</strong></td>
<td><strong>install add tftp://hostname_or_ipaddress/directory-path/mandatory-bundle-pie</strong></td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>RP/0/RSP0/CPU0:router(admin)# install add tftp://10.1.1.1/auto/tftpboot/usr/400/asr9k-mini-p.pie</td>
</tr>
<tr>
<td></td>
<td>Unpacks the mandatory bundle PIE file from a network server and adds the package file to the boot device of the router.</td>
</tr>
<tr>
<td><strong>Note</strong></td>
<td>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 <code>install add</code> command.</td>
</tr>
<tr>
<td><strong>Step 3</strong></td>
<td><strong>install add tftp://hostname_or_ipaddress/directory-path/asr9k-upgrade-p.pie</strong></td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>RP/0/RSP0/CPU0:router(admin)# install add tftp://10.1.1.1/auto/tftpboot/usr/400/asr9k-upgrade-p.pie</td>
</tr>
<tr>
<td></td>
<td>Unpacks the upgrade PIE file from a network server and adds the package file to the boot device of the router.</td>
</tr>
<tr>
<td><strong>Step 4</strong></td>
<td><strong>install activate device:mandatory-bundle-pie device:upgrade-package</strong></td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>RP/0/RSP0/CPU0:router(admin)# install activate disk0:asr9k-mini-p-4.0.0 disk0:asr9k-upgrade-p-4.0.0</td>
</tr>
<tr>
<td></td>
<td>Activates the package that was added to the router together with the upgrade package.</td>
</tr>
<tr>
<td><strong>Note</strong></td>
<td>The bundle of mandatory packages and the upgrade bundle are activated together to perform the successful upgrade from release 3.x to 4.x.</td>
</tr>
<tr>
<td><strong>Step 5</strong></td>
<td><strong>install deactivate devicedevice:upgrade-package</strong></td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>RP/0/RSP0/CPU0:router(admin)# install deactivate disk0:asr9k-upgrade-p-4.0.0</td>
</tr>
<tr>
<td></td>
<td>Deactivates the upgrade package on the router. For specific information regarding the deactivation and removal of software packages, refer to the general procedure.</td>
</tr>
<tr>
<td><strong>Step 6</strong></td>
<td><strong>install commit</strong></td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>RP/0/RSP0/CPU0:router(admin)# install commit</td>
</tr>
<tr>
<td></td>
<td>(Optional) 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.</td>
</tr>
<tr>
<td><strong>Step 7</strong></td>
<td><strong>install remove device:upgrade-package</strong></td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>RP/0/RSP0/CPU0:router=admin)# install remove disk0:asr9k-upgrade-p-4.0.0</td>
</tr>
<tr>
<td></td>
<td>Removes the inactive upgrade package.</td>
</tr>
</tbody>
</table>
The following example illustrates the upgrade operation:

```-template
RP/0/RSP0/CPU0:router (admin) # 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
/tftp://223.255.254.254/auto/tftpboot/users/user/asr9k-mini-p.pie'
started by user 'lab' via CLI at 03:53:12 UTC Fri Jul 09 2010.
The install operation will continue asynchronously.
RP/0/RSP0/CPU0:router (admin) #
Info: The following package is now available to be activated:
Info: disk0:asr9k-mini-p-4.0.0
Info: The package can be activated across the entire router.
Info: RP/0/RP1/CPU0: Jul 9 04:32:26.152 : instdir[235]:
%INSTALL-INSTMGR-6-INSTALL_OPERATION_COMPLETED_SUCCESSFULLY:
Info: Install operation 4 completed successfully
Info: The following package is now available to be activated:
Info: disk0:asr9k-mini-p-4.0.0
Info: The package can be activated across the entire router.
Info: RP/0/RSP0/CPU0:router (admin) #
Info: The following package is now available to be activated:
Info: disk0:asr9k-mini-p-4.0.0
Info: The package can be activated across the entire router.
Info: RP/0/RSP0/CPU0:router (admin) #
Info: The following package is now available to be activated:
Info: disk0:asr9k-mini-p-4.0.0
Info: The package can be activated across the entire router.
```
Info: started by user 'lab' via CLI at 05:23:24 UTC Fri Jul 09 2010. 1% complete:
Info: The operation can still be aborted (ctrl-c for options)
Info: This operation will reload the following nodes in parallel:
Info: 0/RP1/CPU0 (HRP) (SDR: Owner)
Info: 0/SM0/SP (Fabric-SP) (Admin Resource)
Proceed with this install operation (y/n)? [y]
Info: 1% complete: The operation can still be aborted (ctrl-c for options)
Info: Install Method: Parallel Reload/ 1% complete: The operation can still be aborted (ctrl-c for options)
Info: The install operation will continue asynchronously.

RP/0/RP0/CPU0:router#SP/0/SM0/SP:
Jul 9 05:36:41.152 : insthelper[62]: %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
install operation 7 completed successfully at 05:36:43 UTC Fri Jul 09 2010.
rebooting ................... Initializing DDR SDRAM...found 4096 MB
Initializing ECC on bank 0
Initializing ECC on bank 1
Initializing ECC on bank 2
Initializing ECC on bank 3
Turning off data cache, using DDR for first time
Initializing NVRAM...Testing a portion of DDR SDRAM ...done
Reading ID EEPROMs
Initializing EQUID
Initializing PCI ... PCI0 device[1]: Vendor ID 0x10ee
Device ID 0x300e
PCI1 device[1]: Vendor ID 0x1013
Device ID 0x680
Configuring MPPs ...
Configuring FCMCIA slots ...System Bootstrap, Version 1.53(20090331:325342) [CRS-1 ROMMON],
Copyright (c) 1994-2009 by Cisco Systems, Inc.
Acquiring backplane mastership ... successful
Preparing for fan initialization successful
Setting fan speed to 4000 RPMs successful
Reading backplane EEPROM ...
Released backplane mastership ...Board type is 0x100002 (1048576)
Switch 0 Port fe1: link up (100Mb Full Duplex Copper)
Enabling watchdogG4 (7457-NonSMP-MV64360 Rev 3) platform with 4096 MB of main memory....
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
MBI validation sending request.
HIT CTRL-C to abort
No MBI confirmation received from dSChoot: booting from
bootflash:disk0/ps9k-os-mbi-4.0.0/mbias9k-rp.vm

Restricted Rights LegendUse, duplication, or disclosure by the Government is
subject to restrictions as set forth in subparagraph (c) of the Commercial Computer Software
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)
100% complete: The operation can no longer be aborted (ctrl-c for options)

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.
RP/0/RSP0/CPU0:router(admin)#
RP/0/RSP0/CPU0:router(admin)# install remove disk0:
asr9k-upgrade-p-4.0.0
Fri Jul 9 06:04:57.676 UTC
Install operation 11 '(admin) install remove disk0:asr9k-upgrade-p-4.0.0' started
by user 'lab' via CLI at 06:04:58 UTC
Fri Jul 09 2010./
1% complete: The operation can no longer be aborted (ctrl-c for options)
Info: This operation will remove the following packages:
Info: disk0:asr9k-fpd-4.0.0
Info: disk0:asr9k-doc-4.0.0
Info: disk0:asr9k-k9sec-4.0.0
Info: disk0:asr9k-sbc-4.0.0
Info: disk0:asr9k-diags-4.0.0
Info: disk0:asr9k-mgb1-4.0.0
Info: disk0:asr9k-mcast-4.0.0
Info: disk0:asr9k-mpla-4.0.0
Info: disk0:asr9k-rout-4.0.0
Info: disk0:asr9k-fwdg-4.0.0
Info: disk0:asr9k-lc-4.0.0
Info: disk0:asr9k-admin-4.0.0
Info: disk0:asr9k-upgrade-p-4.0.0
1% complete: The operation can no longer be aborted (ctrl-c for options)
Info: This operation will remove the following install rollback point will
Info: no longer be reachable, as the required packages will not be present:
Info: 7?
1% complete: The operation can no longer be aborted (ctrl-c for options)
Proceed with removing these packages? [confirm]
1% complete: The operation can no longer be aborted (ctrl-c for options)
The install operation will continue asynchronously.
RP/0/RSP0/CPU0:router(admin)# SP/0/SM0/SP:Jul 9 06:05:03.902 : envmon[117]: %PLATFORM-ENVMON-4-ALARM : MINOR_HI alarm
cleared by host_temp_Inlet0
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 *Cisco ASR 9000 Series Aggregation Services Router Interface and Hardware Component Configuration Guide*.

**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>Connect to the console port and log in. Establishes a CLI management session with the SDR. Connect to the console port for the active DSC. For more information on console connections, see <em>Cisco ASR 9000 Series Aggregation Services Router Getting Started Guide</em>.</td>
</tr>
<tr>
<td><strong>Step 2</strong></td>
<td>admin</td>
</tr>
<tr>
<td>Example:</td>
<td>RP/0/RSP0/CPU0:router# admin</td>
</tr>
<tr>
<td><strong>Step 3</strong></td>
<td><strong>install deactivate</strong> {id add-id</td>
</tr>
<tr>
<td>Example:</td>
<td>RP/0/RSP0/CPU0:router(admin)# install deactivate disk0:asr9k-diags-3.7.2</td>
</tr>
<tr>
<td>• To deactivate all packages that were added in one or more specific install add operations, or specify packages by name, use the <strong>id add-id</strong> 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 <strong>show install log</strong> command.</td>
<td></td>
</tr>
<tr>
<td>• Use the <strong>location node-id</strong> keyword and argument to deactivate the package for a specific node, if supported.</td>
<td></td>
</tr>
<tr>
<td>• Use the <strong>pause sw-change</strong> keywords to pause the operation after preparatory checks and before the configuration is locked for the actual</td>
<td></td>
</tr>
</tbody>
</table>
Deactivating and Removing Cisco IOS XR Software Packages

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>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.</td>
</tr>
</tbody>
</table>

**Note** Press ? after a partial package name to display all possible matches available for deactivation. If there is only one match, press [TAB] to fill in the rest of the package name.

When a package is deactivated for an SDR from administration EXEC mode, a notification message appears on the console for that SDR, with information on the impact of the deactivation.

<table>
<thead>
<tr>
<th>Step 4</th>
<th>show install inactive summary</th>
<th>(Optional) Displays the inactive packages on the router.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Example:</td>
<td>RP/0/RSP0/CPU0:router(admin)# show install inactive summary</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Step 5</th>
<th>install verify packages</th>
<th>(Optional) 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.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Example:</td>
<td>RP/0/RSP0/CPU0:router(admin)# install verify packages</td>
<td></td>
</tr>
</tbody>
</table>

**Note** The install verify packages command can take up to two minutes per package to process.

<table>
<thead>
<tr>
<th>Step 6</th>
<th>exit</th>
<th>Exits administration EXEC mode and returns to EXEC mode.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Example:</td>
<td>RP/0/RSP0/CPU0:router(admin)# exit</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Step 7</th>
<th>show system verify start</th>
<th>(Optional) Starts the system status check.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Example:</td>
<td>RP/0/RSP0/CPU0:router# show system verify start</td>
<td></td>
</tr>
</tbody>
</table>

| Step 8 | show system verify [ detail | report ] | (Optional) 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 |
### Command or Action

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>• <strong>detail</strong>—Displays additional information at the card and processor level, including actual numbers.</td>
<td></td>
</tr>
<tr>
<td>• <strong>report</strong>—Displays the same information as the default <strong>show system verify</strong> command</td>
<td></td>
</tr>
</tbody>
</table>

**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.

**Step 9** admin

*Example:* RP/0/RSP0/CPU0:router# admin

Enables administration EXEC mode.

**Step 10** install commit

*Example:* RP/0/RSP0/CPU0:router(admin)# install commit

(Optional) 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 mode.

**Step 11** install remove { id add-id | device : package | inactive } [ test ]

*Example:* RP/0/RSP0/CPU0:router(admin)# install remove disk0:asr9k-diags-3.8.30

(Optional) 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.

**Related Topics**

Adding and Activating Packages, on page 48
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:
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# 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 committed` 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.

```
RP/0/RSP0/CPU0:router# admin
RP/0/RSP0/CPU0:router (admin)# show install rollback ?
```

<table>
<thead>
<tr>
<th>ID</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>ID of the rollback point to show package information for</td>
</tr>
<tr>
<td>2</td>
<td>ID of the rollback point to show package information for</td>
</tr>
</tbody>
</table>
In this example, the rollback points are 0 and 2. The rollback point with the highest number is the current software point. For example, if the last installation operation was operation 3 (activating the MPLS package) then the highest rollback point is 3, which is the same as the current software (MPLS package activated).

To easily identify specific rollback points, you can assign a label or description to a rollback point using the `install label` command.

You can enter the command in either administration EXEC mode or EXEC mode.

## 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/asr9k-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/asr9k-os-mbi-3.9.0.12I/1c/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/asr9k-os-mbi-3.9.0.12I/1c/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/asr9k-os-mbi-3.9.0.12I/1c/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 *Cisco ASR 9000 Series Aggregation Services Router System Management Command Reference.*
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:

```bash
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:

```bash
RP/0/RSP0/CPU0:router(admin)# install rollback to committed
Install operation 27 'install rollback to committed' started by user 'lab' at
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
```

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>
</tr>
</thead>
<tbody>
<tr>
<td>Cisco IOS XR install commands</td>
<td>Software Package Management Commands on the Cisco ASR 9000 Series Router module of Cisco ASR 9000 Series Aggregation Services Router System Management Command Reference</td>
</tr>
<tr>
<td>Cisco IOS XR getting started material</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 Cisco ASR 9000 Series Aggregation Services Router System Security Configuration Guide</td>
</tr>
<tr>
<td>ROM Monitor</td>
<td>Cisco ASR 9000 Series Aggregation Services Router ROM Monitor 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>
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 83. 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 11: 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>
</tbody>
</table>

This module contains the following topics:

- Disk Mirroring Prerequisites, page 75
- Information About Disk Mirroring, page 76
- How to Enable Disk Mirroring, page 77
- Configuration Examples for Enabling Disk Mirroring, page 82
- Additional References, page 83

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.

Note

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 76

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 12: Size of Disk Partitions in Relation to Size of Disk, on page 76.

Table 12: 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>
</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>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
</table>
| Step 1 | `format secondary-device partition [ location node-id ]` | Partitions the secondary storage device into two partitions.  
- If the device is already partitioned, you do not need to perform this step.  
  
  **Example:**  
  `RP/0/RSP0/CPU0:router# format disk1: partition` |
| Step 2 | Remove any noncritical data from the primary boot device. | 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: . |
| Step 3 | `configure` | Enables disk mirroring of the `primary-device` to the `secondary-device` . |
| Step 4 | `mirror location node-id Primary-device Secondary-device` | If the primary boot device is not partitioned, the following occurs: |
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]
## Configuring Disk Mirroring

### Replacing the Secondary Mirroring Device

#### DETAILED STEPS

<table>
<thead>
<tr>
<th></th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td><code>show mirror [location node-id]</code></td>
<td>Verifies that mirroring is active. In the output, the <em>Current Mirroring State</em> should be redundant.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td><code>RP/0/RSP0/CPU0:router# show mirror</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 2</strong></td>
<td><code>mirror pause [location node-id]</code></td>
<td>Temporarily pauses disk mirroring.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td><code>RP/0/RSP0/CPU0:router# mirror pause</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong></td>
<td><code>show mirror [location node-id]</code></td>
<td>Verifies that mirroring has paused. In the output, the <em>Current Mirroring State</em> should be paused.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td><code>RP/0/RSP0/CPU0:router# show mirror</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 4</strong></td>
<td><code>unmount secondary-device [location node-id]</code></td>
<td>Unmounts the secondary device.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td><code>RP/0/RSP0/CPU0:router# unmount disk1:</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 5</strong></td>
<td>Remove the device and insert a new device.</td>
<td></td>
</tr>
<tr>
<td><strong>Step 6</strong></td>
<td><code>format secondary-device partition [location node-id]</code></td>
<td>Formats the device.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td><code>RP/0/RSP0/CPU0:router# format disk1: partition</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 7</strong></td>
<td><code>show media [location node-id]</code></td>
<td>Verifies that the device is formatted. The output should display the device that you formatted.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td><code>RP/0/RSP0/CPU0:router# show media</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 8</strong></td>
<td><code>mirror resume [location node-id]</code></td>
<td>Resumes mirroring.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td><code>RP/0/RSP0/CPU0:router# mirror resume</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 9</strong></td>
<td><code>show mirror [location node-id]</code></td>
<td>Verifies that mirroring has restarted. In the output, the <em>Current Mirroring State</em> should be Syncing. 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 <em>Current Mirroring State</em> should be Redundant.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<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.
10. `show media [location node-id]`
11. (Optional) `format secondary-device partition [location node-id]`
12. `mirror resume [location node-id]`
13. `show mirror [location node-id]`
14. `configure`
15. `mirror location node-id Primary-device Secondary-device`
16. `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> 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>Example: <code>RP/0/RSP0/CPU0:router# show mirror</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 2</strong> <code>configure</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong> mirror location node-id Primary-device Secondary-device</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>Example: <code>RP/0/RSP0/CPU0:router(config)# mirror location 0/ RSP0</code></td>
<td></td>
</tr>
</tbody>
</table>
### Purpose

**Command or Action**

<table>
<thead>
<tr>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>/CPU0 disk1:disk0:</td>
</tr>
</tbody>
</table>

**Step 4**

Commit

**Step 5**

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.

**Command or Action**

<table>
<thead>
<tr>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>show mirror [location node-id]</td>
</tr>
</tbody>
</table>

**Example:**

RP/0/RSP0/CPU0:router# show mirror

**Step 6**

Temporarily pauses disk mirroring.

**Command or Action**

<table>
<thead>
<tr>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>mirror pause [location node-id]</td>
</tr>
</tbody>
</table>

**Example:**

RP/0/RSP0/CPU0:router# mirror pause

**Step 7**

Verifies that mirroring has paused. In the output, the *Current Mirroring State* should be paused.

**Command or Action**

<table>
<thead>
<tr>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>show mirror</td>
</tr>
</tbody>
</table>

**Example:**

RP/0/RSP0/CPU0:router# show mirror

**Step 8**

Unmounts the secondary device which is the device that you want to replace. Initially, this was the primary device.

**Command or Action**

<table>
<thead>
<tr>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>unmount secondary-device [location node-id]</td>
</tr>
</tbody>
</table>

**Example:**

RP/0/RSP0/CPU0:router# unmount disk1:

**Step 9**

Remove the device and insert a new device.

**Step 10**

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.

**Command or Action**

<table>
<thead>
<tr>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>show media [location node-id]</td>
</tr>
</tbody>
</table>

**Example:**

RP/0/RSP0/CPU0:router# show media

**Step 11**

(Optional) Formats the device. You only need to perform this step if the new device is not partitioned.

**Command or Action**

<table>
<thead>
<tr>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>format secondary-device partition [location node-id]</td>
</tr>
</tbody>
</table>

**Example:**

RP/0/RSP0/CPU0:router# format disk1: partition

**Step 12**

Resumes mirroring.

**Command or Action**

<table>
<thead>
<tr>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>mirror resume [location node-id]</td>
</tr>
</tbody>
</table>

**Example:**

RP/0/RSP0/CPU0:router# mirror resume

**Step 13**

Verifies that mirroring has restarted. In the output, the *Current Mirroring State* should be Syncing.

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.

**Command or Action**

<table>
<thead>
<tr>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>show mirror [location node-id]</td>
</tr>
</tbody>
</table>

**Example:**

RP/0/RSP0/CPU0:router# show mirror
<table>
<thead>
<tr>
<th>Step 14</th>
<th><strong>configure</strong></th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 15</td>
<td><strong>mirror location node-id Primary-device Secondary-device</strong></td>
<td>Swaps the device roles back so that the newly inserted device becomes the primary device.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>RP/0/RSP0/CPU0:router(config)# mirror location 0/</td>
<td></td>
</tr>
<tr>
<td></td>
<td>RSP0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>/CPU0 disk0:disk1:</td>
<td></td>
</tr>
<tr>
<td>Step 16</td>
<td><strong>show mirror [location node-id]</strong></td>
<td>Verifies that the new device is now the primary device.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>RP/0/RSP0/CPU0:router# show mirror</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:                           |
+---------------------------------------------------------------+
```
Configuring Disk Mirroring

Physical Device State Flags

<table>
<thead>
<tr>
<th>Physical Device</th>
<th>State</th>
<th>Flags</th>
</tr>
</thead>
<tbody>
<tr>
<td>disk0:</td>
<td>Available</td>
<td>Enabled</td>
</tr>
<tr>
<td>disk1:</td>
<td>Available</td>
<td>Enabled</td>
</tr>
<tr>
<td>compactflash:</td>
<td>Available</td>
<td></td>
</tr>
<tr>
<td>(null):</td>
<td>Available</td>
<td></td>
</tr>
<tr>
<td>disk0a:</td>
<td>Available</td>
<td></td>
</tr>
<tr>
<td>disk1a:</td>
<td>Available</td>
<td></td>
</tr>
<tr>
<td>compactflasha:</td>
<td>Not Present</td>
<td></td>
</tr>
<tr>
<td>harddisk:</td>
<td>Available</td>
<td></td>
</tr>
</tbody>
</table>

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# 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 Cisco ASR 9000 Series Aggregation Services Router System Security Configuration Guide</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 Cisco ASR 9000 Series Aggregation Services Router System Management Command Reference</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>
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.

For complete descriptions of the commands listed in this module, see Related Documents, on page 96. 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 13: 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>
</tbody>
</table>

This model contains the following topics:

- What Is Software Entitlement?, page 85
- Implementing Default Licensing, page 87
- Additional References, page 95

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 *Cisco ASR 9000 Series Aggregation Services Router MPLS Configuration Guide* 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 *Cisco ASR 9000 Series Aggregation Services Router Interface and Hardware Component Configuration Guide*.

**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 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>
</table>
| Step 1

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> show license udi</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>
| **Example:** ```
RP/0/RSP0/CPU0:router(admin)# 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](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 | Enters administration EXEC mode.  
**Example:** ```
RP/0/RSP0/CPU0:router# admin
``` |
| **Step 6** license add license-name [ sdr sdr-name ] | Adds the license to the SDR license pool. By default, the license is added to the owner SDR license pool. |
| **Example:** ```
RP/0/RSP0/CPU0:router(admin)# license add tftp://192.10.10.10/mylicenses/lc40g_lic
``` |
| **Step 7** configure | Enters administration configuration mode. |
| **Example:** ```
RP/0/RSP0/CPU0:router(admin)# configure
``` |
| **Step 8** license license-name location {all | node-id} | (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. |
| **Example:** ```
RP/0/RSP0/CPU0:router(config)# license A9K-ADV-OPTIC-LIC location 0/0/CPU0
``` |
### Purpose

**Command or Action**

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

### Example:

```
RP/0/RSP0/CPU0:router# admin
```

### Step 2

**Command or Action**

```
license backup backup-file
```

**Example:**

```
RP/0/RSP0/CPU0:router(bootflash)# license backup disk1:/license_back
License command "license backup disk1:/license_back" completed successfully.
```

---

**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 Cisco ASR 9000 Series Aggregation Services Router MPLS Configuration Guide.

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

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

**Example:**

```
RP/0/RSP0/CPU0:router(bootflash)# license backup disk1:/license_back
License command "license backup disk1:/license_back" completed successfully.
```
### Examples

The following example shows sample output from the `show license backup` command.

```
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>Step 1</td>
<td>admin</td>
</tr>
<tr>
<td>Example:</td>
<td>RP/0/RSP0/CPU0:router# admin</td>
</tr>
<tr>
<td>Step 2</td>
<td>show license backup backup-file</td>
</tr>
<tr>
<td>Example:</td>
<td>RP/0/RSP0/CPU0:router(admin)# show license backup disk1:/license_back</td>
</tr>
<tr>
<td>Step 3</td>
<td>license restore backup-file</td>
</tr>
<tr>
<td>Example:</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 88.

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. Stores the license files in a location that is accessible to the new RSP after it is installed.</td>
</tr>
<tr>
<td><strong>Step 2</strong></td>
<td>save configuration running 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.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td><code>RP/0/RSP0/CPU0:router(config)# configure</code></td>
<td></td>
</tr>
<tr>
<td><code>RP/0/RSP0/CPU0:router(config)# save configuration running tftp://192.10.10.10/mylicenses/rc_03132013</code></td>
<td></td>
</tr>
<tr>
<td><code>RP/0/RSP0/CPU0:router(config)# exit</code></td>
<td></td>
</tr>
<tr>
<td><code>RP/0/RSP0/CPU0:router# admin</code></td>
<td></td>
</tr>
<tr>
<td><code>RP/0/RSP0/CPU0:router(admin)# configure</code></td>
<td></td>
</tr>
<tr>
<td><code>RP/0/RSP0/CPU0:router(admin-config)# save configuration running tftp://192.10.10.10/mylicenses/rc_admin_03132013</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong></td>
<td>Replace the RSP with the RSP440.</td>
</tr>
<tr>
<td><strong>Step 4</strong></td>
<td>load Loads the saved running-configuration files on the new RSP440. This must be done in both global configuration mode and administration configuration mode.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td><code>RP/0/RSP0/CPU0:router(config)# load tftp://192.10.10.10/mylicenses/rc_03132013</code></td>
<td></td>
</tr>
<tr>
<td><code>RP/0/RSP0/CPU0:router(config)# exit</code></td>
<td></td>
</tr>
<tr>
<td><code>RP/0/RSP0/CPU0:router# admin</code></td>
<td></td>
</tr>
<tr>
<td><code>RP/0/RSP0/CPU0:router(admin)# configure</code></td>
<td></td>
</tr>
<tr>
<td><code>RP/0/RSP0/CPU0:router(admin-config)# load tftp://192.10.10.10/mylicenses/rc_admin_03132013</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 5</strong></td>
<td>Add all licenses as described in Adding a License for a New Feature, on page 88. Installs the licenses to the new RSP.</td>
</tr>
</tbody>
</table>
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 88 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></td>
<td>Enters administration EXEC mode.</td>
</tr>
<tr>
<td>admin</td>
<td></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 2</strong></td>
<td>Adds the license to the license pool.</td>
</tr>
<tr>
<td>license add license-name</td>
<td></td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>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></td>
<td>Enters administration configuration mode.</td>
</tr>
<tr>
<td>configure</td>
<td></td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>RP/0/RSP0/CPU0:router{admin)# configure</td>
<td></td>
</tr>
<tr>
<td><strong>Step 4</strong></td>
<td>(Optional) Binds the license to the slot where it is used.</td>
</tr>
<tr>
<td>license license-name location {all</td>
<td>node-id }</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>RP/0/RSP0/CPU0:router{admin-config)# license</td>
<td></td>
</tr>
<tr>
<td><strong>Note</strong></td>
<td>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>Command or Action</td>
<td>Purpose</td>
</tr>
<tr>
<td>-------------------</td>
<td>---------</td>
</tr>
</tbody>
</table>
| A9K-24X10G-AIP-TR location 0/0/CPU0 | Associates the new license on the slot with the new line card.  
*Note:* You need to wait for the new line cards to boot. |

**Step 5**  
Remove the old line cards and install the new ones.

**Step 6**  
**show license**

**Example:**

```
RP/0/RSP0/CPU0:router# show license
Thu May 31 08:52:39.876 PST
FeatureID: A9K-24X10G-AIP-TR (Slot based, Permanent)
  Total licenses 1
  Available for use 0
  Allocated to location 0
  Active 1
  Store name Permanent
  Store index 3
  Pool: Owner
    Total licenses in pool: 1
    Status: Available 0 Operational: 1
    Locations with licenses: (Active/Allocated) [SDR]
      0/0/CPU0 (1/0) [Owner]
```

**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
```

**Additional References**

The following sections provide references related to Cisco IOS XR software entitlement.
## Related Documents

<table>
<thead>
<tr>
<th>Related Topic</th>
<th>Document Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cisco IOS XR software entitlement commands</td>
<td>Software Entitlement Commands on the Cisco ASR 9000 Series Router module of Cisco ASR 9000 Series Aggregation Services Router System Management Command Reference</td>
</tr>
<tr>
<td>Layer 2 VPN configuration</td>
<td>Implementing MPLS Layer 2 VPNs module of Cisco ASR 9000 Series Aggregation Services Router MPLS Configuration Guide</td>
</tr>
<tr>
<td>Layer 3 VPN configuration</td>
<td>Implementing MPLS Layer 3 VPNs on the Cisco ASR 9000 Series Router module of Cisco ASR 9000 Series Aggregation Services Router MPLS Configuration Guide</td>
</tr>
<tr>
<td>Cisco IOS XR software commands</td>
<td>Cisco ASR 9000 Series Aggregation Services Router Commands Master List</td>
</tr>
<tr>
<td>Information on 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 Cisco ASR 9000 Series Aggregation Services Router System Security Configuration 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>
Managing the 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 127. 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 14: 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>
</tbody>
</table>

This module contains the following topics:

- Prerequisites for Managing Router Hardware, page 100
- Displaying Hardware Status, page 100
- RSP Redundancy and Switchover, page 115
- Reloading, Shutting Down, or Power Cycling a Node, page 119
- Flash Disk Recovery, page 122
- Using Controller Commands to Manage Hardware Components, page 123
- Formatting Hard Drives, Flash Drives, and Other Storage Devices, page 123
- Removing and Replacing Cards, page 124
- Upgrading the CPU Controller Bits, page 126
- Additional References, page 127
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:  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/CLPD/ASIC Hardware Revision:
      Compact Flash : V1.0
      XbarSwitch0  : V1.3
      XbarSwitch1  : V1.3
      XbarArbiter  : V1.0
      XbarInterface : V0.0
      IntCtrl1     : V1.14
      CLKCtrl1     : V1.13
      PuntFPGA     : V1.5
      HD           : V3.0
      USB0         : V77.20
      USB1         : V77.20
      CPUCtrl1     : V1.17
      SCI          : V1.6
      LIU           : V1.0
      MLANSwitch   : V0.0
      EOBCSwitch   : V2.0
      CBC (active partition) : v1.2
      CBC (inactive partition) : v1.1
```
Displaying SDR Hardware Version Information

NODE module 0/1/CPU0:

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: FOC123081JA
Top Assy. Number: 68-3183-02
PID: A9K-8T/4-B
UDI_VID: V1D
HwRev: V0.0
New Deviation Number: 0
CLEI: IPUSAEO198
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
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: FH112250033
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/CLLD/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/CP0:router#show diag
Mon Jun 29 01:21:04.571 PST
NODE module 0/RSP0/CP0 :
   MAIN: board type 0x100302
   S/N: FCI230803H
   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/CPID/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
      PunctFPGA : 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:
```
Displaying System Hardware Version Information

Managing the Router Hardware

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/SF:
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: 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
  CPUCtrl : V0.15
  USB : V77.20
  PortCtrl : V0.8
  PHYCtrl : V0.6
  40 Port Gigabit Ethernet Daughter board : V0.0
  CBC (active partition) : 2.2
  CBC (inactive partition) : 2.2

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
Managing the Router Hardware

Displaying System Hardware Version Information

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: V10  
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  
PHY4 : V0.16  
PHY5 : V0.16  
PHY6 : V0.16  
PHY7 : V0.16  
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-3KN-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
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[DT_IMAGE]
Copyright (c) 2009 by Cisco Systems, Inc.
ROM: System Bootstrap, Version 1.1(20090521:183759) [ASR9K ROMMON],
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.
33994M bytes of hard disk.
1605416k bytes of disk0: (Sector size 512 bytes).
1605416k 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

asr9k-adv-video, V 3.9.0.16I[DT_IMAGE], Cisco Systems, at disk0:asr9k-adv-video-3.9.0.16I
Built on Thu Jul 30 13:49:37 DST 2009
By sjc-lds-208 in /auto/ioxbuild7/production/3.9.0.16I.DT_IMAGE/asr9k/workspace for
c4.2.1-p0

asr9k-fpd, V 3.9.0.16I[DT_IMAGE], Cisco Systems, at disk0:asr9k-fpd-3.9.0.16I
Built on Thu Jul 30 12:26:21 DST 2009
By sjc-lds-208 in /auto/ioxbuild7/production/3.9.0.16I.DT_IMAGE/asr9k/workspace for
c4.2.1-p0

asr9k-diags, V 3.9.0.16I[DT_IMAGE], Cisco Systems, at disk0:asr9k-diags-3.9.0.16I
Built on Thu Jul 30 12:09:43 DST 2009
By sjc-lds-208 in /auto/ioxbuild7/production/3.9.0.16I.DT_IMAGE/asr9k/workspace for
c4.2.1-p0

asr9k-k9sec, V 3.9.0.16I[DT_IMAGE], Cisco Systems, at disk0:asr9k-k9sec-3.9.0.16I
Built on Thu Jul 30 12:25:25 DST 2009
By sjc-lds-208 in /auto/ioxbuild7/production/3.9.0.16I.DT_IMAGE/asr9k/workspace for
c4.2.1-p0

asr9k-mgbl, V 3.9.0.16I[DT_IMAGE], Cisco Systems, at disk0:asr9k-mgbl-3.9.0.16I

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,NSHUT,MON
0/1/CPU0 A9K-40GE-B IOS XR RUN PWR,NSHUT,MON
0/4/CPU0 A9K-8T/4-B IOS XR RUN PWR,NSHUT,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 15: Node ID Components, on page 108 summarizes the node-id for each type of card.

### Table 15: Node ID Components

<table>
<thead>
<tr>
<th>Card Type (the card to which your are issuing commands)</th>
<th>Rack (always “0”)</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>show platform
Sat Mar 24 05:02:18.569 DST
Node Type State Config State
------- ------- -----
```
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 15: Node ID Components, on page 108 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/CPU0:router(admin)# show environment
Mon Jun 29 04:32:07.587 PST

Temperature Information
-------------------------------
R/S/I Modules Inlet Hotspot
   Temperature (deg C) Temperature (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
0/1/* host IBV 10647 n/a
     host 5.0V 4929 n/a
```
### Displaying Router Environment Information

<table>
<thead>
<tr>
<th>Host</th>
<th>Voltage</th>
<th>Address</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>VFP3P_CAN</td>
<td>3288</td>
<td>n/a</td>
<td></td>
</tr>
<tr>
<td>3.3V</td>
<td>3301</td>
<td>n/a</td>
<td></td>
</tr>
<tr>
<td>2.5V</td>
<td>2516</td>
<td>n/a</td>
<td></td>
</tr>
<tr>
<td>1.8VB</td>
<td>1810</td>
<td>n/a</td>
<td></td>
</tr>
<tr>
<td>1.2VB</td>
<td>1193</td>
<td>n/a</td>
<td></td>
</tr>
<tr>
<td>1.8VA</td>
<td>1800</td>
<td>n/a</td>
<td></td>
</tr>
<tr>
<td>0.9VB</td>
<td>884</td>
<td>n/a</td>
<td></td>
</tr>
<tr>
<td>1.2V_LDO_BRG0</td>
<td>1193</td>
<td>n/a</td>
<td></td>
</tr>
<tr>
<td>1.2V_LDO_BRG1</td>
<td>1195</td>
<td>n/a</td>
<td></td>
</tr>
<tr>
<td>1.8VC</td>
<td>1811</td>
<td>n/a</td>
<td></td>
</tr>
<tr>
<td>1.5V</td>
<td>1505</td>
<td>n/a</td>
<td></td>
</tr>
<tr>
<td>1.5VA</td>
<td>1503</td>
<td>n/a</td>
<td></td>
</tr>
<tr>
<td>1.8V(1.05V_CPU)</td>
<td>1052</td>
<td>n/a</td>
<td></td>
</tr>
<tr>
<td>0.75VA</td>
<td>751</td>
<td>n/a</td>
<td></td>
</tr>
<tr>
<td>0.75VB_0.75VC</td>
<td>754</td>
<td>n/a</td>
<td></td>
</tr>
<tr>
<td>1.1VB</td>
<td>1102</td>
<td>n/a</td>
<td></td>
</tr>
<tr>
<td>1.2V_TCAM0</td>
<td>1003</td>
<td>n/a</td>
<td></td>
</tr>
<tr>
<td>1.2V_TCAM1</td>
<td>1000</td>
<td>n/a</td>
<td></td>
</tr>
<tr>
<td>1.0V_Bridge_LDO</td>
<td>998</td>
<td>n/a</td>
<td></td>
</tr>
<tr>
<td>1.0V</td>
<td>1043</td>
<td>n/a</td>
<td></td>
</tr>
<tr>
<td>0.75VD_and_0.75VE</td>
<td>752</td>
<td>n/a</td>
<td></td>
</tr>
<tr>
<td>1.2V_TCAM2</td>
<td>1005</td>
<td>n/a</td>
<td></td>
</tr>
<tr>
<td>1.2V_TCAM3</td>
<td>1002</td>
<td>n/a</td>
<td></td>
</tr>
<tr>
<td>1.5VC</td>
<td>1504</td>
<td>n/a</td>
<td></td>
</tr>
<tr>
<td>1.8VD</td>
<td>1803</td>
<td>n/a</td>
<td></td>
</tr>
<tr>
<td>1.1VC</td>
<td>1099</td>
<td>n/a</td>
<td></td>
</tr>
<tr>
<td>ZARLINK_3.3V</td>
<td>3272</td>
<td>n/a</td>
<td></td>
</tr>
<tr>
<td>ZARLINK_1.8V</td>
<td>1808</td>
<td>n/a</td>
<td></td>
</tr>
<tr>
<td>1.2V_DB</td>
<td>1195</td>
<td>n/a</td>
<td></td>
</tr>
<tr>
<td>3.3V_DB</td>
<td>3316</td>
<td>n/a</td>
<td></td>
</tr>
<tr>
<td>2.5V_DB</td>
<td>2534</td>
<td>n/a</td>
<td></td>
</tr>
<tr>
<td>1.8V_DB</td>
<td>1509</td>
<td>n/a</td>
<td></td>
</tr>
</tbody>
</table>

0/RSP0/*

<table>
<thead>
<tr>
<th>Host</th>
<th>Voltage</th>
<th>Address</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.75VTT</td>
<td>749</td>
<td>n/a</td>
<td></td>
</tr>
<tr>
<td>0.9VTT_A</td>
<td>910</td>
<td>n/a</td>
<td></td>
</tr>
<tr>
<td>0.9VTT_B</td>
<td>904</td>
<td>n/a</td>
<td></td>
</tr>
<tr>
<td>IBV</td>
<td>10586</td>
<td>n/a</td>
<td></td>
</tr>
<tr>
<td>5.0V</td>
<td>5013</td>
<td>n/a</td>
<td></td>
</tr>
<tr>
<td>VFP3P_CAN</td>
<td>3277</td>
<td>n/a</td>
<td></td>
</tr>
<tr>
<td>3.3V</td>
<td>3299</td>
<td>n/a</td>
<td></td>
</tr>
<tr>
<td>2.5V</td>
<td>2518</td>
<td>n/a</td>
<td></td>
</tr>
<tr>
<td>1.8VB</td>
<td>1807</td>
<td>n/a</td>
<td></td>
</tr>
<tr>
<td>1.2VA</td>
<td>1205</td>
<td>n/a</td>
<td></td>
</tr>
<tr>
<td>1.2VB</td>
<td>1202</td>
<td>n/a</td>
<td></td>
</tr>
<tr>
<td>1.05V</td>
<td>1047</td>
<td>n/a</td>
<td></td>
</tr>
<tr>
<td>1.2VD</td>
<td>1205</td>
<td>n/a</td>
<td></td>
</tr>
<tr>
<td>1.8VA</td>
<td>1811</td>
<td>n/a</td>
<td></td>
</tr>
<tr>
<td>1.5V</td>
<td>1496</td>
<td>n/a</td>
<td></td>
</tr>
<tr>
<td>1.9V</td>
<td>1887</td>
<td>n/a</td>
<td></td>
</tr>
</tbody>
</table>

0/4/*

<table>
<thead>
<tr>
<th>Host</th>
<th>Voltage</th>
<th>Address</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>IBV</td>
<td>10627</td>
<td>n/a</td>
<td></td>
</tr>
<tr>
<td>5.0V</td>
<td>4917</td>
<td>n/a</td>
<td></td>
</tr>
<tr>
<td>VFP3P_CAN</td>
<td>3279</td>
<td>n/a</td>
<td></td>
</tr>
<tr>
<td>3.3V</td>
<td>3296</td>
<td>n/a</td>
<td></td>
</tr>
<tr>
<td>2.5V</td>
<td>2522</td>
<td>n/a</td>
<td></td>
</tr>
<tr>
<td>1.8VB</td>
<td>1805</td>
<td>n/a</td>
<td></td>
</tr>
<tr>
<td>1.2VB</td>
<td>1188</td>
<td>n/a</td>
<td></td>
</tr>
<tr>
<td>1.8VA</td>
<td>1796</td>
<td>n/a</td>
<td></td>
</tr>
<tr>
<td>0.9WB</td>
<td>881</td>
<td>n/a</td>
<td></td>
</tr>
<tr>
<td>1.2V_LDO_BRG0</td>
<td>1192</td>
<td>n/a</td>
<td></td>
</tr>
<tr>
<td>1.2V_LDO_BRG1</td>
<td>1195</td>
<td>n/a</td>
<td></td>
</tr>
<tr>
<td>1.8VC</td>
<td>1806</td>
<td>n/a</td>
<td></td>
</tr>
<tr>
<td>1.5VB</td>
<td>1510</td>
<td>n/a</td>
<td></td>
</tr>
<tr>
<td>1.5VA</td>
<td>1503</td>
<td>n/a</td>
<td></td>
</tr>
<tr>
<td>1.1V(1.05V_CPU)</td>
<td>1048</td>
<td>n/a</td>
<td></td>
</tr>
<tr>
<td>0.75VA</td>
<td>753</td>
<td>n/a</td>
<td></td>
</tr>
<tr>
<td>0.75VB_0.75VC</td>
<td>757</td>
<td>n/a</td>
<td></td>
</tr>
<tr>
<td>1.1VB</td>
<td>1105</td>
<td>n/a</td>
<td></td>
</tr>
<tr>
<td>1.2V_TCAM0</td>
<td>1003</td>
<td>n/a</td>
<td></td>
</tr>
<tr>
<td>1.2V_TCAM1</td>
<td>1000</td>
<td>n/a</td>
<td></td>
</tr>
<tr>
<td>1.0V_Bridge_LDO</td>
<td>997</td>
<td>n/a</td>
<td></td>
</tr>
</tbody>
</table>
Managing the Router Hardware

Displaying Router Environment Information

---

**LED Information**

R/S/I Modules LED Status

0/RSP0/*

host 0.75VB_and_0.75VE 755 n/a
host 1.2V_TCAM2 1004 n/a
host 1.2V_TCAM3 1005 n/a
host 1.5VC 1505 n/a
host 1.8VD 1808 n/a
host 1.1VC 1104 n/a
host ZARLINK_3.3V 3285 n/a
host ZARLINK_1.8V 1806 n/a
host 1.2V_DB 1205 n/a
host 3.3V_DB 3318 n/a
host 2.5V_DB 2493 n/a
host 1.5V_DB 1497 n/a
host 1.8V_DB 1825 n/a
host 5.0V_XFP_DB 5001 n/a
host 1.2VB_DB 1228 n/a

0/6/*

host IBV 10628 n/a
host 5.0V 4893 n/a
host VP3P3_CAN 3281 n/a
host 3.3V 3297 n/a
host 2.5V 2524 n/a
host 1.8VB 1804 n/a
host 1.2VB 1204 n/a
host 1.8VA 1795 n/a
host 0.9VB 881 n/a
host 1.2V_LDO_BRG0 1194 n/a
host 1.2V_LDO_BRG1 1193 n/a
host 1.8VC 1815 n/a
host 1.5VB 1495 n/a
host 1.5VA 1503 n/a
host 1.1V(1.05V_CPU) 1052 n/a
host 0.75VA 752 n/a
host 0.75VB_0.75VC 749 n/a
host 1.1VB 1001 n/a
host 1.2V_TCAM0 999 n/a
host 1.2V_TCAM1 1002 n/a
host 1.0V_Bridge_LDO 995 n/a
host 1.0VB 1050 n/a
host 0.75VD_and_0.75VE 752 n/a
host 1.2V_TCAM2 1002 n/a
host 1.2V_TCAM3 995 n/a
host 1.5VC 1502 n/a
host 1.8VD 1802 n/a
host 1.1VC 1101 n/a
host ZARLINK_3.3V 3273 n/a
host ZARLINK_1.8V 1804 n/a
host 1.2V_DB 1200 n/a
host 3.3V_DB 3314 n/a
host 2.5V_DB 2496 n/a
host 1.5V_DB 1496 n/a
host 1.8V_DB 1824 n/a
host 5.0V_XFP_DB 5004 n/a
host 1.2VB_DB 1227 n/a

**Fan Information**

Fan speed (rpm):

<table>
<thead>
<tr>
<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>
<th>FAN10</th>
<th>FAN11</th>
</tr>
</thead>
</table>

---

Cisco ASR 9000 Series Aggregation Services Router System Management Configuration Guide, Release 5.1.x
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: Turboboos 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/RSP1/CPU0:router# show hw-module fpd location all
```

Mon Jun 29 05:38:50.332 PST

---

### Existing Field Programmable Devices
---

<table>
<thead>
<tr>
<th>Location</th>
<th>Card Type</th>
<th>HW Current SW Upg/</th>
<th>Type</th>
<th>Subtype</th>
<th>Inst</th>
<th>Version</th>
<th>Dng?</th>
</tr>
</thead>
<tbody>
<tr>
<td>0/RSP0/CPU0</td>
<td>A9K-RSP-4G</td>
<td>lc</td>
<td>fpga3</td>
<td>0</td>
<td>1.13</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>lc</td>
<td>fpga1</td>
<td>0</td>
<td>1.5</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>lc</td>
<td>fpga2</td>
<td>0</td>
<td>1.14</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>lc</td>
<td>cbc</td>
<td>0</td>
<td>1.2</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>lc</td>
<td>fpga4</td>
<td>0</td>
<td>1.6</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>lc</td>
<td>rommon</td>
<td>0</td>
<td>1.0</td>
<td>No</td>
<td></td>
</tr>
</tbody>
</table>

---

<table>
<thead>
<tr>
<th>Location</th>
<th>Card Type</th>
<th>HW Current SW Upg/</th>
<th>Type</th>
<th>Subtype</th>
<th>Inst</th>
<th>Version</th>
<th>Dng?</th>
</tr>
</thead>
<tbody>
<tr>
<td>0/RSP0/CPU0</td>
<td>ASR-9010-FAN</td>
<td>lc</td>
<td>cbc</td>
<td>1</td>
<td>4.0</td>
<td>No</td>
<td></td>
</tr>
</tbody>
</table>

---

<table>
<thead>
<tr>
<th>Location</th>
<th>Card Type</th>
<th>HW Current SW Upg/</th>
<th>Type</th>
<th>Subtype</th>
<th>Inst</th>
<th>Version</th>
<th>Dng?</th>
</tr>
</thead>
<tbody>
<tr>
<td>0/RSP0/CPU0</td>
<td>ASR-9010-FAN</td>
<td>lc</td>
<td>cbc</td>
<td>2</td>
<td>4.0</td>
<td>No</td>
<td></td>
</tr>
</tbody>
</table>

---

<table>
<thead>
<tr>
<th>Location</th>
<th>Card Type</th>
<th>HW Current SW Upg/</th>
<th>Type</th>
<th>Subtype</th>
<th>Inst</th>
<th>Version</th>
<th>Dng?</th>
</tr>
</thead>
<tbody>
<tr>
<td>0/1/CPU0</td>
<td>A9K-40GE-B</td>
<td>lc</td>
<td>fpga1</td>
<td>0</td>
<td>0.38</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>lc</td>
<td>fpga2</td>
<td>0</td>
<td>0.8</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>lc</td>
<td>cbc</td>
<td>0</td>
<td>2.2</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>lc</td>
<td>cpld1</td>
<td>0</td>
<td>0.15</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>lc</td>
<td>rommon</td>
<td>0</td>
<td>1.0</td>
<td>No</td>
<td></td>
</tr>
</tbody>
</table>

---

<table>
<thead>
<tr>
<th>Location</th>
<th>Card Type</th>
<th>HW Current SW Upg/</th>
<th>Type</th>
<th>Subtype</th>
<th>Inst</th>
<th>Version</th>
<th>Dng?</th>
</tr>
</thead>
<tbody>
<tr>
<td>0/1/CPU0</td>
<td>A9K-40GE-B</td>
<td>lc</td>
<td>fpga1</td>
<td>1</td>
<td>0.38</td>
<td>No</td>
<td></td>
</tr>
</tbody>
</table>

---

<table>
<thead>
<tr>
<th>Location</th>
<th>Card Type</th>
<th>HW Current SW Upg/</th>
<th>Type</th>
<th>Subtype</th>
<th>Inst</th>
<th>Version</th>
<th>Dng?</th>
</tr>
</thead>
<tbody>
<tr>
<td>0/4/CPU0</td>
<td>A9K-8T/4-B</td>
<td>lc</td>
<td>fpga1</td>
<td>0</td>
<td>0.38</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>lc</td>
<td>fpga2</td>
<td>0</td>
<td>0.10</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>lc</td>
<td>cbc</td>
<td>0</td>
<td>2.2</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>lc</td>
<td>cpld2</td>
<td>0</td>
<td>0.7</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>lc</td>
<td>cpld1</td>
<td>0</td>
<td>0.15</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>lc</td>
<td>cpld3</td>
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<td>0.3</td>
<td>No</td>
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<tr>
<td></td>
<td></td>
<td>lc</td>
<td>rommon</td>
<td>0</td>
<td>1.42</td>
<td>No</td>
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<table>
<thead>
<tr>
<th>Location</th>
<th>Card Type</th>
<th>HW Current SW Upg/</th>
<th>Type</th>
<th>Subtype</th>
<th>Inst</th>
<th>Version</th>
<th>Dng?</th>
</tr>
</thead>
<tbody>
<tr>
<td>0/4/CPU0</td>
<td>A9K-8T/4-B</td>
<td>lc</td>
<td>fpga1</td>
<td>1</td>
<td>0.38</td>
<td>No</td>
<td></td>
</tr>
</tbody>
</table>

---

<table>
<thead>
<tr>
<th>Location</th>
<th>Card Type</th>
<th>HW Current SW Upg/</th>
<th>Type</th>
<th>Subtype</th>
<th>Inst</th>
<th>Version</th>
<th>Dng?</th>
</tr>
</thead>
<tbody>
<tr>
<td>0/6/CPU0</td>
<td>A9K-4T-B</td>
<td>lc</td>
<td>fpga1</td>
<td>0</td>
<td>0.38</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>lc</td>
<td>fpga2</td>
<td>0</td>
<td>0.10</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>lc</td>
<td>cbc</td>
<td>0</td>
<td>2.2</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>lc</td>
<td>cpld2</td>
<td>0</td>
<td>0.7</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>lc</td>
<td>cpld1</td>
<td>0</td>
<td>0.15</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>lc</td>
<td>cpld3</td>
<td>0</td>
<td>0.3</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>lc</td>
<td>rommon</td>
<td>0</td>
<td>1.0</td>
<td>No</td>
<td></td>
</tr>
</tbody>
</table>
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

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

Table 16: 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>
</tbody>
</table>
| Type | Hardware type. Can be one of the following types:  
  - spa—Shared port adapter  
  - lc—Line card |
### Field and Description

<table>
<thead>
<tr>
<th>Field</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<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</td>
</tr>
<tr>
<td></td>
<td>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</td>
</tr>
<tr>
<td></td>
<td>required in rare cases when the version of the FPD image has a higher major</td>
</tr>
<tr>
<td></td>
<td>revision than the version of the FPD image in the current Cisco IOS XR</td>
</tr>
<tr>
<td></td>
<td>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 3: Redundant Set of RSPs Installed in Slots RSP0 and RSP1 in an 8-Slot Chassis, on page 116). 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 3: 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 17: RSP Redundancy Commands, on page 117 to display the redundancy status of the cards or force a manual switchover.

### Table 17: RSP Redundancy Commands

<table>
<thead>
<tr>
<th>Command</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>show redundancy</strong></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><strong>redundancy switchover</strong></td>
<td>Forces a manual switchover to the standby RSP. This command works only if the standby RSP is installed and in the &quot;ready&quot; state.</td>
</tr>
<tr>
<td><strong>show platform</strong></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 119

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: xxxxx
Password: xxxxx
Last switch-over Sat Apr 15 12:26:47 2009: 1 minute ago

RP/0/RSP1/CPU0:router#

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.

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 18: Commands to Reload, Shut Down, or Power Cycle a Node, on page 120 summarizes the commands described in this section.

**Table 18: Commands to Reload, Shut Down, or Power Cycle a Node**

<table>
<thead>
<tr>
<th>Command</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>hw-module location node-id power disable</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 commit command. To power on a node, use the no form of this command.</td>
</tr>
<tr>
<td></td>
<td><strong>Note</strong> This command cannot be used to disable power on the RSP from which the command is entered.</td>
</tr>
<tr>
<td>hw-module location node-id reload</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 all keyword in place of the node-id argument. The node reloads with the current running configuration and active software set for that node.</td>
</tr>
<tr>
<td>hw-module shutdown location node-id</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 no form of this command.</td>
</tr>
<tr>
<td></td>
<td><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 *Cisco ASR 9000 Series Aggregation Services Router ROM Monitor Guide*. 
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>
</table>
| **Step 1** show redundancy| Displays the RSP redundancy status.  
| Example: RP/0/RSP0/CPU0:router# show redundancy |  
|                           | • If a standby RSP is in "ready" redundancy state, the `reload` command also causes the router to gracefully fail over to the standby RSP. |
| **Step 2** admin         | Enters administration EXEC mode. |
| Example: RP/0/RSP0/CPU0:router# admin | |
| **Step 3** show variables boot | Displays the configuration register setting.  
| Example: RP/0/RSP0/CPU0:router@admin# show variables boot |  
|                           | • Enter this command in administration EXEC mode.  
|                           | • For normal operations, the configuration register setting is 0x102 or 0x2102, which causes the active RSP to reload the Cisco IOS XR software.  
|                           | • Verify that the configuration register setting is 0x102 or 0x2102. If it is not, complete Step 4, on page 121 to reset the configuration register to 0x102 or 0x2102.  
<p>| <strong>Note</strong> For instructions on how to enter ROM Monitor bootstrap mode, see Cisco ASR 9000 Series Aggregation Services Router ROM Monitor Guide. |
| <strong>Step 4</strong> config-register register-value | <em>(Optional)</em> Sets the configuration register to the respective value. This step is necessary only if the register is not set to the respective value (0x102 or 0x2102) in the running configuration. You can use either 0x102 or 0x2102. Both these values |</p>
<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>admin</td>
<td>Enters administration EXEC mode.</td>
</tr>
</tbody>
</table>

**Step 5**

Example:

```
RP/0/RSP0/CPU0:router# admin
```

**Step 6**

Example:

```
RP/0/RSP0/CPU0:router# reload
```

Reloads the active RSP according to the configuration register setting.

- If the setting is 0x102 or 0x2102, then the RSP reloads the Cisco IOS XR software.
- If the standby RSP is in “ready” redundancy state, the router switches over to the standby RSP.
- If a standby RSP is not installed or not in a “ready” state, the router experiences a loss of service while the active RSP is reloading the Cisco IOS XR software.

---

**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:

```
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.
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 *Cisco ASR 9000 Series Aggregation Services Router Interface and Hardware Component Command Reference*.

Formatting Hard Drives, Flash Drives, and Other Storage Devices

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

Formatting a storage device deletes all data on that device.

The following command syntax is used:

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

Table 19: `format command Syntax Description`, on page 123 describes the `format` command syntax.

<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 <code>format ?</code> to see the devices supported on your router.</td>
</tr>
</tbody>
</table>
### Variable Description

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>options</strong></td>
<td>Enter <code>format filesystem: ?</code> to see the available options. For more information, see <em>Cisco ASR 9000 Series Aggregation Services Router System Management Command Reference</em>.</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
```

---

**Cisco ASR 9000 Series Aggregation Services Router System Management Configuration Guide, Release 5.1.x**
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 124 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 124 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/CP00: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 124 apply. Review the running configuration in the router and revise the configuration as necessary for the new media type.

**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 cpucrtlbits {all | 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></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>RP/0/RSP0/CPU0:router# admin</td>
<td></td>
</tr>
<tr>
<td>Step 2</td>
<td>upgrade cpucrtlbits {all</td>
<td>location node-id}</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>RP/0/RSP0/CPU0:router(admin)# upgrade cpucrtlbits all</td>
<td></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 Cisco ASR 9000 Series Aggregation Services Router System Management Command Reference</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>Cisco ASR 9000 Series Aggregation Services Router ROM Monitor Guide</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 Cisco ASR 9000 Series Aggregation Services Router System Security Configuration 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>
CHAPTER 8

Configuring Flexible Command Line Interface Configuration Groups

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

Table 20: 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, page 129
- Flexible Configuration Restrictions, page 130
- Configuring a Configuration Group, page 131
- Verifying the Configuration of Configuration Groups, page 133
- Apply Groups Priority Inheritance, page 135
- Regular Expressions in Configuration Groups, page 136
- Configuration Examples for Flexible CLI Configuration, page 143

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

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

```plaintext
 групп 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.

### 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>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>group group-name</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>3</td>
<td></td>
<td>Enter configuration commands, starting from global configuration mode. Use regular expressions for interface names and other variable instances. For more information regarding the use of regular expressions, see Regular Expressions in Configuration Groups, on page 136. This example is applicable to all Gigabit Ethernet interfaces.</td>
</tr>
<tr>
<td>4</td>
<td>end-group</td>
<td>Completes the configuration of a configuration group and exits to global configuration mode.</td>
</tr>
<tr>
<td>5</td>
<td>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. The MTU value from the group g-interf is applied to the interface GigabitEthernet0/2/0/0. If this group is applied in global configuration mode, the MTU value is inherited by all Gigabit Ethernet interfaces that do not have an MTU value configured.</td>
</tr>
</tbody>
</table>

Example:

```
RP/0/RSP0/CPU0:router(config)# group g-interf
RP/0/RSP0/CPU0:router(config-GRP)# interface 'GigabitEthernet.*'
RP/0/RSP0/CPU0:router(config-GRP-if)# mtu 1500
```
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.*'
    mtu 1500
RP/0/RSP0/CPU0:router(config-GRP-if)# exit
RP/0/RSP0/CPU0:router(config-GRP)# interface 'GigabitEthernet.*'
    mtu 1000
RP/0/RSP0/CPU0:router(config-GRP-if)# exit
RP/0/RSP0/CPU0:router(config-GRP)# interface 'POS.*'
    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
RP/0/RSP0/CPU0:router(config-if)# ipv4 address 3.3.3.3 255.255.255.0
```

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

Verifying the Configuration of Configuration Groups

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

1. show running-config group [group-name]
2. show running-config
3. show running-config inheritance
4. show running-config interface x/y/z inheritance config-command

DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1 show running-config group [group-name]</td>
<td>Displays the contents of a specific or all configured configuration groups.</td>
</tr>
<tr>
<td>Example: show running-config group [group-name]</td>
<td>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.</td>
</tr>
<tr>
<td>RP/0/RSP0/CPU0:router# show running-config group</td>
<td>config-command</td>
</tr>
<tr>
<td>group g-int-ge</td>
<td>interface 'GigabitEthernet.**'</td>
</tr>
<tr>
<td>mtu 1000</td>
<td>negotiation auto</td>
</tr>
<tr>
<td>!</td>
<td>end-group</td>
</tr>
<tr>
<td>Step 2 show running-config</td>
<td>Displays the inherited configuration where ever a configuration group has been applied.</td>
</tr>
<tr>
<td>Example: show running-config</td>
<td>config-command</td>
</tr>
<tr>
<td>RP/0/RSP0/CPU0:router# show running-config</td>
<td>group G-INTERFACE-MTU</td>
</tr>
<tr>
<td>interface 'POS.*'</td>
<td>mtu 1500</td>
</tr>
<tr>
<td>!</td>
<td>end-group</td>
</tr>
<tr>
<td>interface POS0/4/1/0</td>
<td>apply-group G-INTERFACE-MTU</td>
</tr>
<tr>
<td>!</td>
<td>interface POS0/4/1/1</td>
</tr>
<tr>
<td>apply-group G-INTERFACE-MTU</td>
<td>mtu 2000</td>
</tr>
<tr>
<td>!</td>
<td>end-group</td>
</tr>
<tr>
<td>Step 3 show running-config inheritance</td>
<td>config-command</td>
</tr>
<tr>
<td>Example: show running-config inheritance</td>
<td>group G-INTERFACE-MTU</td>
</tr>
<tr>
<td>interface 'POS.*'</td>
<td>mtu 1500</td>
</tr>
<tr>
<td>!</td>
<td>end-group</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### 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.

```bash
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 states two scenarios. Inner most group (apply-group ONE TWO) has the highest priority.

**Case 1**
In the first scenario it shows which group gets the first priority. The example states which group is applied between different configuration groups (different groups- nothing in common between them). While applying the group one (ONE TWO), all the seven groups that matches to the interface `interface GigabitEthernet 0/0/0/0` will be applied.
Case 2

In the case when all these groups (mentioned above) have same (common) configuration, group one will be active. The apply-group ONE TWO will be active. If group ONE is deleted then group TWO will be active.

**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 130 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)
MgmtEth 'RegExp': Ethernet/IEEE 802.3 interface(s)
Multilink 'RegExp': Multilink network interface(s)
Null   'RegExp': Null interface
POS    'RegExp': Packet over SONET/SDH network interface(s)
PW-Ether 'RegExp': PWHE Ethernet Interface
PW-IN  'RegExp': PWHE VCI1 IP Interworking Interface
Serial 'RegExp': Serial network interface(s)
tunnel-ip 'RegExp': GRE/IPinIP Tunnel Interface(s)
tunnel-mte 'RegExp': MPLS Traffic Engineering P2MP Tunnel interface(s)
tunnel-te 'RegExp': MPLS Traffic Engineering Tunnel interface(s)
tunnel-tp 'RegExp': MPLS Transport Protocol Tunnel interface
```

---

**Note**

Although you are required to enter only enough characters for the interface type to be unique, it is recommended that you enter the entire phrase. All interface types used in regular expressions are case-sensitive.
To specify a subinterface, prefix the expression with the characters \ (backslash period). For example, use
interface 'GigabitEthernet.*\..*' to configure all Gigabit Ethernet subinterfaces.

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

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

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

**Regular Expressions for an OSPF Configuration**

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

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

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

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

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

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

**Regular Expressions for a BGP AS**

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

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

Cisco ASR 9000 Series Aggregation Services Router System Management Configuration Guide, Release 5.1.x
Regular Expressions for ANCP

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

Resolving to a Uniform Type

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

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

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

---

**Note**

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

---

**Note**

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

---

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
```
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 GigabitEthernet0/0/0/0/1
  lsp-interval 20
  hello-interval 40
  address-family ipv4 unicast
  metric 10
!
interface GigabitEthernet0/0/0/0/2
  lsp-interval 20
  hello-interval 40
  address-family ipv4 unicast
  metric 10
!
interface GigabitEthernet0/0/0/0/3
  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 GigabitEthernet0/0/0/0/1
  apply-group g-isis-gige
!
interface GigabitEthernet0/0/0/0/2
  apply-group g-isis-gige
!
interface GigabitEthernet0/0/0/0/3
  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 GigabitEthernet0/0/0/0/1
!
interface GigabitEthernet0/0/0/0/2
!
```
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-ar)# packet-size 2000
RP/0/RSP0/CPU0:router(config-GRP-ospf)# 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 g-ospf2 is inherited by OSPF area 0 because the group is applied in a more inner configuration mode. In this case, the configuration in group g-ospf100 is ignored.

```
RP/0/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
```

**Changes to Configuration Group are Automatically Inherited: Example**

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

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

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

Now you change the configuration group as in this example:

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

When this configuration group is committed, the MTU configuration for interface POS0/4/1/0 is automatically updated to 2000.
Basic Flexible CLI Configuration: Example

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

1 Configure the configuration group that configures MAC accounting:

```
RP/0/RSP0/CPU0# show running group gd21

group gd21
interface 'GigabitEthernet0/0/0/2[1-9]' description general interface inheritance check
load-interval 30
mac-accounting ingress
mac-accounting egress
end-group
```

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

```
RP/0/RSP0/CPU0# 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# 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# 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
mac-accounting ingress
## Inherited from group gd21
mac-accounting egress
!
interface GigabitEthernet0/0/0/22
## Inherited from group gd21
description general interface inheritance check
## Inherited from group gd21
load-interval 30
## Inherited from group gd21
mac-accounting ingress
## Inherited from group gd21
mac-accounting egress
!`
5 Verify that the inherited configuration actually takes effect:

```
RP/0/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
  Total: 774 packets, 63264 bytes
```

### Interface MTU Settings for Different Interface Types: Example

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

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

```
RP/0/RSP0/CPU0:router# show running group l2tr
group l2tr
  interface 'GigabitEthernet0/0/0/3.*'
    mtu 1500
  !
  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 l2transport
  encapsulation dot1q 250
!
RP/0/RSP0/CPU0:router# show running inheritance interface gigabitEthernet0/0/0/9.800
interface GigabitEthernet0/0/0/9.250 l2transport
  encapsulation dot1q250
  ## Inherited from group l2tr
  mtu 1400
!

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

RP/0/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, 1000Mbit/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 packets output, 0 bytes, 0 total output drops
    Output 0 broadcast packets, 0 multicast packets
RP/0/RSP0/CPU0:router# show interface gigabitEthernet 0/0/0/9.250
GigabitEthernet0/0/0/9.250 is up, line protocol is up
  Interface state transitions: 1
  Hardware is VLAN sub-interface(s), address is 0026.9824.ee41
  Layer 2 Transport Mode
  MTU 1400 bytes, BW 1000000 Kbit (Max: 1000000 Kbit)
  Encapsulation 802.1Q Virtual LAN,
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
   !
   RP/0/RSP0/CPU0:router# show running inheritance interface GigabitEthernet 0/0/0/30
   ## Inherited from group l2tr
   mtu 1500
   ## Inherited from group acref
   ipv4 access-group adem ingress
   ## Inherited from group acref
   ipv4 access-group adem egress
   !

   RP/0/RSP0/CPU0:router# show running interface GigabitEthernet 0/0/0/31
   !
   RP/0/RSP0/CPU0:router# show running inheritance interface GigabitEthernet 0/0/0/31
   ## Inherited from group l2tr
   mtu 1500
   ## Inherited from group acref
   ipv4 access-group adem ingress
   ## Inherited from group acref
   ipv4 access-group adem egress
3 Check that the ACL group configuration actually got configured by using a traffic generator and watching that denied traffic is dropped.

**Local Configuration Takes Precedence: Example**

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

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

```
RP/0/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 interface gigabitEthernet 0/0/0/38
interface GigabitEthernet0/0/0/38
!
```

```
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 'GigabitEthernet0/0/0/3.*'
  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
```

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
mtu 1500
## Inherited from group acref
ipv4 access-group adem ingress
## Inherited from group acref
ipv4 access-group adem egress
!

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

**ISIS Hierarchical Configuration: Example**

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

1 Configure the local ISIS configuration:

RP/0/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
!
2 Configure two ISIS groups and apply these to the configuration:

```plaintext
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
    !
  !
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.*"
    !
  interface "^(Ten)Gig.*"
    address-family ipv4 unicast
    metric 66
    !
  !
end-group

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

Building configuration...

apply-group isis l2tr 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
## Inherited from group isis
address-family ipv4 unicast
## Inherited from group isis
metric 50

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

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

interface TenGigE0/2/0/1
## Inherited from group isis
lsp-interval 40
## Inherited from group isis
hello-interval 15
## Inherited from group isis
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.*'
        cost 300
      !
    !
  end-group
3 Check the inheritance view and verify that the apply-group in the lowest configuration submode gets the highest priority:

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

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

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

RP/0/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
Link Bundling Usage: Example
Upgrading FPD

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, see Related Documents, on page 189. 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 21: Feature History for Upgrading FPD Software on Cisco IOS XR Software

<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 6.4.1</td>
<td>Support for parallel FPD upgrade for power modules.</td>
</tr>
</tbody>
</table>

This module contains the following topics:

- Prerequisites for FPD Image Upgrades, page 158
- Overview of FPD Image Upgrade Support, page 158
- How to Upgrade FPD Images, page 159
- Configuration Examples for FPD Image Upgrade, page 163
- Troubleshooting Problems with FPD Image Upgrades, page 188
- Additional References, page 189
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.

Related Topics

- `show hw-module fpd Command Output: Example`, on page 163

Automatic FPD Upgrade

By default, 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.

However, if you enable the `fpd auto-upgrade` command in Admin Configuration mode, FPD images are automatically updated when:

- Software upgrade is carried out.

The following conditions must be met for an Automatic FPD Upgrade to work:

- FPD package installation envelope (PIE) must already 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 enabled.
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:

- Line cards or other cards such as RSPs, SPAs or alarm cards are added to an existing router.
- 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.

### 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 severely up-rev (V2.1), downgrade to (V1.6). Use the "upgrade hw-module fpd" 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.

FAILED to upgrade fpga3 for 4-100GbE on location1/1/CPU0 from 34.00 to 37.00
LC/1/1/CPU0:Nov 12 15:28:40.057 : lc_fpd_upgrade[244]: %PLATFORM-UPGRADE_FPD-3-OPERATION_FAILED : Failed to update FPD : FPD Programming action failed on this card.

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>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td>Displays the current FPD image versions for the specified card or all cards installed in the router. Use this command to determine if you must upgrade the FPD image on your card.</td>
</tr>
<tr>
<td>show hw-module fpd location {all</td>
<td>node-id}</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>RP/0/RSP0/CPU0:router# show hw-module fpd location all or RP/0/RSP0/CPU0:router# show hw-module fpd location 0/4/cpu0</td>
</tr>
<tr>
<td><strong>Step 2</strong></td>
<td>Enters administration EXEC mode.</td>
</tr>
<tr>
<td>admin</td>
<td></td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>RP/0/RSP0/CPU0:router# admin</td>
</tr>
<tr>
<td><strong>Step 3</strong></td>
<td>(Optional) 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>show fpd package</td>
<td></td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>RP/0/RSP0/CPU0:router(admin)# show fpd package</td>
</tr>
<tr>
<td><strong>Step 4</strong></td>
<td>Upgrades all the current FPD images that must be upgraded on the specified card with new images. Before continuing to the next step, wait for confirmation that the FPD upgrade has successfully completed. Status messages, similar to these, are displayed to the screen until the FPD upgrade is completed:</td>
</tr>
<tr>
<td>upgrade hw-module fpd {all</td>
<td>fpga-type} [ force] location {all</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>RP/0/RSP0/CPU0:router(admin)# upgrade hw-module fpd all location 0/3/1. . . Successfully upgraded 1 FPD for SPA-2XOC48POS/RPR on location 0/3/1</td>
</tr>
</tbody>
</table>

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.
### Purpose
If Ctrl-C is pressed while the FPD upgrade is in progress, the following warning message is displayed:

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)]

If you confirm that you want to abort the FPD upgrade procedure, this message is displayed:

FPD upgrade process has been aborted, please check the status of the hardware and reissue the upgrade command if required.

**Note**
If your card supports multiple FPD images, you can use the `show pdpackage` admin command to determine what specific image to upgrade in the `upgrade hw-module pd` command.

**Note**
A message is displayed when router modules cannot get upgraded during upgrade with location all option indicating that the FPGA is intentionally skipped during upgrade. To upgrade such FPGAs, you can use the CLI command with a particular location explicitly specified. For example, `upgrade hw-module pd all location 0/3/1`.

### Step 5  exit

**Example:**
RP/0/RSP0/CPU0:router(admin)# exit

Exits administration EXEC mode and returns to EXEC mode.

### Step 6  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

(Optional)
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.

### 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` command 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/RSP1/CPU0:router# show hw-module fpd location all
```

```
Mon Jun 29 05:38:50.332 PST

<table>
<thead>
<tr>
<th>Location</th>
<th>Card Type</th>
<th>HW Current SW Upg/Version</th>
<th>Type</th>
<th>Subtype</th>
<th>Inst Version</th>
<th>Dng?</th>
</tr>
</thead>
<tbody>
<tr>
<td>0/RSP0/CPU0</td>
<td>A9K-RSP-4G</td>
<td>4.8 lc fpga3 0</td>
<td>1.13</td>
<td>No</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>lc fpga1 0</td>
<td>1.5</td>
<td>No</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>lc fpga2 0</td>
<td>1.14</td>
<td>No</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>lc cbc 0</td>
<td>1.2</td>
<td>No</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>lc fpga4 0</td>
<td>1.6</td>
<td>No</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>lc rommon 0</td>
<td>1.0</td>
<td>No</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Location</th>
<th>Card Type</th>
<th>HW Current SW Upg/Version</th>
<th>Type</th>
<th>Subtype</th>
<th>Inst Version</th>
<th>Dng?</th>
</tr>
</thead>
<tbody>
<tr>
<td>0/RSP0/CPU0</td>
<td>ASR-9010-FAN</td>
<td>1.0 lc cbc 1</td>
<td>4.0</td>
<td>No</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0/RSP0/CPU0</td>
<td>ASR-9010-FAN</td>
<td>1.0 lc cbc 2</td>
<td>4.0</td>
<td>No</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0/1/CPU0</td>
<td>A9K-40GE-B</td>
<td>1.0 lc fpga1 0</td>
<td>0.38</td>
<td>No</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>lc fpga2 0</td>
<td>0.8</td>
<td>No</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>lc cbc 0</td>
<td>2.2</td>
<td>No</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>lc cpld1 0</td>
<td>0.15</td>
<td>No</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>lc rommon 0</td>
<td>1.0</td>
<td>No</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Location</th>
<th>Card Type</th>
<th>HW Current SW Upg/Version</th>
<th>Type</th>
<th>Subtype</th>
<th>Inst Version</th>
<th>Dng?</th>
</tr>
</thead>
<tbody>
<tr>
<td>0/1/CPU0</td>
<td>A9K-40GE-B</td>
<td>1.0 lc fpga1 1</td>
<td>0.38</td>
<td>No</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0/4/CPU0</td>
<td>A9K-8T/4-B</td>
<td>1.0 lc fpga1 0</td>
<td>0.38</td>
<td>No</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>lc fpga2 0</td>
<td>0.10</td>
<td>No</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>lc cbc 0</td>
<td>2.2</td>
<td>No</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>lc cpld2 0</td>
<td>0.7</td>
<td>No</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>lc cpld1 0</td>
<td>0.15</td>
<td>No</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>lc cpld3 0</td>
<td>0.3</td>
<td>No</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>lc rommon 0</td>
<td>1.0</td>
<td>No</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>lc fpga3 0</td>
<td>14.42</td>
<td>No</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Location</th>
<th>Card Type</th>
<th>HW Current SW Upg/Version</th>
<th>Type</th>
<th>Subtype</th>
<th>Inst Version</th>
<th>Dng?</th>
</tr>
</thead>
<tbody>
<tr>
<td>0/4/CPU0</td>
<td>A9K-8T/4-B</td>
<td>1.0 lc fpga1 1</td>
<td>0.38</td>
<td>No</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0/6/CPU0</td>
<td>A9K-4T-B</td>
<td>1.0 lc fpga1 0</td>
<td>0.38</td>
<td>No</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>lc fpga2 0</td>
<td>0.10</td>
<td>No</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>lc cbc 0</td>
<td>2.2</td>
<td>No</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>lc cpld2 0</td>
<td>0.7</td>
<td>No</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>lc cpld1 0</td>
<td>0.15</td>
<td>No</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>lc cpld3 0</td>
<td>0.3</td>
<td>No</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>lc rommon 0</td>
<td>1.0</td>
<td>No</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>lc fpga3 0</td>
<td>14.42</td>
<td>No</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Location</th>
<th>Card Type</th>
<th>HW Current SW Upg/Version</th>
<th>Type</th>
<th>Subtype</th>
<th>Inst Version</th>
<th>Dng?</th>
</tr>
</thead>
<tbody>
<tr>
<td>0/6/CPU0</td>
<td>A9K-4T-B</td>
<td>1.0 lc fpga1 1</td>
<td>0.38</td>
<td>No</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
```
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

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

Table 22: 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>
</tbody>
</table>
FPD type. Can be one of the following types:

- fabldr — Fabric downloader
- fpga1 — Field-programmable gate array
- fpga2 — Field-programmable gate array 2
- fpga3 — Field-programmable gate array 3
- fpga4 — Field-programmable gate array 4
- fpga5 — Field-programmable gate array 5
- rommonA — Read-only memory monitor A
- rommon — Read-only memory monitor B

FPD instance. The FPD instance uniquely identifies an FPD and is used by the FPD process to register an FPD.

Currently running FPD image version. 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.

**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
============================================================================
Card Type FPD Description Type Subtype Version SW Ver HW Vers
============================================================================
A9K-40GE-B Can Bus Ctrl (CBC) LC2 lc cbc 2.02 0.0 0.1
CPUCtrl LC2 lc cpld1 1.00 0.0 0.1
PHYCtrl LC2 lc cpld2 0.06 0.0 0.1
```
### show fpd package Command Output: Example

<table>
<thead>
<tr>
<th>System Type</th>
<th>Configuration</th>
<th>Platform</th>
<th>Status</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>A9K-4T-B</td>
<td>Can Bus Ctrl (CBC)</td>
<td>LC2</td>
<td></td>
<td>2.02</td>
</tr>
<tr>
<td></td>
<td>CPUCtrl</td>
<td>lc cbc</td>
<td></td>
<td>2.02</td>
</tr>
<tr>
<td></td>
<td>PHYCtrl</td>
<td>lc cpld1</td>
<td></td>
<td>2.02</td>
</tr>
<tr>
<td></td>
<td>LCClkCtrl</td>
<td>lc cpld2</td>
<td></td>
<td>2.02</td>
</tr>
<tr>
<td></td>
<td>PortCtrl</td>
<td>lc fpga2</td>
<td></td>
<td>2.02</td>
</tr>
<tr>
<td></td>
<td>PHY</td>
<td>lc fpga3</td>
<td></td>
<td>2.02</td>
</tr>
<tr>
<td></td>
<td>Bridge</td>
<td>lc fpga1</td>
<td></td>
<td>2.02</td>
</tr>
<tr>
<td></td>
<td>ROMMONB</td>
<td>lc rommon</td>
<td></td>
<td>2.02</td>
</tr>
</tbody>
</table>

### A9K-8T/4-B

<table>
<thead>
<tr>
<th>System Type</th>
<th>Configuration</th>
<th>Platform</th>
<th>Status</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>A9K-8T/4-B</td>
<td>Can Bus Ctrl (CBC)</td>
<td>LC2</td>
<td></td>
<td>2.02</td>
</tr>
<tr>
<td></td>
<td>CPUCtrl</td>
<td>lc cbc</td>
<td></td>
<td>2.02</td>
</tr>
<tr>
<td></td>
<td>PHYCtrl</td>
<td>lc cpld1</td>
<td></td>
<td>2.02</td>
</tr>
<tr>
<td></td>
<td>LCClkCtrl</td>
<td>lc cpld2</td>
<td></td>
<td>2.02</td>
</tr>
<tr>
<td></td>
<td>PortCtrl</td>
<td>lc fpga2</td>
<td></td>
<td>2.02</td>
</tr>
<tr>
<td></td>
<td>PHY</td>
<td>lc fpga3</td>
<td></td>
<td>2.02</td>
</tr>
<tr>
<td></td>
<td>Bridge</td>
<td>lc fpga1</td>
<td></td>
<td>2.02</td>
</tr>
<tr>
<td></td>
<td>ROMMONB</td>
<td>lc rommon</td>
<td></td>
<td>2.02</td>
</tr>
</tbody>
</table>

### A9K-2T20GE-B

<table>
<thead>
<tr>
<th>System Type</th>
<th>Configuration</th>
<th>Platform</th>
<th>Status</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>A9K-2T20GE-B</td>
<td>Can Bus Ctrl (CBC)</td>
<td>LC2</td>
<td></td>
<td>2.02</td>
</tr>
<tr>
<td></td>
<td>CPUCtrl</td>
<td>lc cbc</td>
<td></td>
<td>2.02</td>
</tr>
<tr>
<td></td>
<td>PHYCtrl</td>
<td>lc cpld1</td>
<td></td>
<td>2.02</td>
</tr>
<tr>
<td></td>
<td>LCClkCtrl</td>
<td>lc cpld2</td>
<td></td>
<td>2.02</td>
</tr>
<tr>
<td></td>
<td>PortCtrl</td>
<td>lc fpga2</td>
<td></td>
<td>2.02</td>
</tr>
<tr>
<td></td>
<td>Bridge</td>
<td>lc fpga1</td>
<td></td>
<td>2.02</td>
</tr>
<tr>
<td></td>
<td>ROMMONB</td>
<td>lc rommon</td>
<td></td>
<td>2.02</td>
</tr>
</tbody>
</table>

### A9K-40GE-E

<table>
<thead>
<tr>
<th>System Type</th>
<th>Configuration</th>
<th>Platform</th>
<th>Status</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>A9K-40GE-E</td>
<td>Can Bus Ctrl (CBC)</td>
<td>LC2</td>
<td></td>
<td>2.02</td>
</tr>
<tr>
<td></td>
<td>CPUCtrl</td>
<td>lc cbc</td>
<td></td>
<td>2.02</td>
</tr>
<tr>
<td></td>
<td>PHYCtrl</td>
<td>lc cpld1</td>
<td></td>
<td>2.02</td>
</tr>
<tr>
<td></td>
<td>PortCtrl</td>
<td>lc fpga2</td>
<td></td>
<td>2.02</td>
</tr>
<tr>
<td></td>
<td>Bridge</td>
<td>lc fpga1</td>
<td></td>
<td>2.02</td>
</tr>
<tr>
<td></td>
<td>ROMMONA</td>
<td>lc rommonA</td>
<td></td>
<td>2.02</td>
</tr>
<tr>
<td></td>
<td>ROMMONB</td>
<td>lc rommon</td>
<td></td>
<td>2.02</td>
</tr>
<tr>
<td>Model</td>
<td>Controller (CBC)</td>
<td>LC</td>
<td>Package</td>
<td>Clock Speed</td>
</tr>
<tr>
<td>--------------</td>
<td>------------------</td>
<td>----</td>
<td>---------</td>
<td>-------------</td>
</tr>
<tr>
<td>A9K-4T-E</td>
<td>Can Bus Ctrl</td>
<td>lc</td>
<td>cbc</td>
<td>2.02</td>
</tr>
<tr>
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<td>CPUCtrl</td>
<td>lc</td>
<td>cpld1</td>
<td>1.00</td>
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<td>PHYCtrl</td>
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<td>cpld2</td>
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<td>LCClkCtrl</td>
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<td>cpld3</td>
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</tr>
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<td>PortCtrl</td>
<td>lc</td>
<td>fpga2</td>
<td>0.10</td>
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<td>PHY</td>
<td>lc</td>
<td>fpga3</td>
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<td>Bridge</td>
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<td>fpga1</td>
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<td>rommon</td>
<td>1.05</td>
</tr>
<tr>
<td>A9K-8T/4-E</td>
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<td>lc</td>
<td>cbc</td>
<td>2.02</td>
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<td>CPUCtrl</td>
<td>lc</td>
<td>cpld1</td>
<td>1.00</td>
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<tr>
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<td>LCClkCtrl</td>
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show fpd package Command Output: Example

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PortCtrl LC3    lc  fpga2  0.11  0.0  0.1
Raven LC3       lc  fpga1  1.02  0.0  0.1
ROMMONB LC3     lc  rommon 1.03  0.0  0.1

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PHYCtrl LC3    lc  cpld2  0.04  0.0  0.1
LCCLKCtrl LC3  lc  cpld3  0.01  0.0  0.1
DB CPUCtrl LC3 lc  cpld4  1.03  0.0  0.1
PortCtrl LC3   lc  fpga2  0.01  0.0  0.1
Raven LC3      lc  fpga1  1.02  0.0  0.1
ROMMONB LC3    lc  rommon 1.03  0.0  0.1

A9K-SIP-700
Can Bus Ctrl (CBC) LC5   lc  cbc  3.05  0.0  0.1
CPUCtrl LC5     lc  cpld1  0.15  0.0  0.1
QFPCPUBridge LC5 lc  fpga2  5.14  0.0  0.1
NPUXBarBridge LC5 lc  fpga1  0.22  0.0  0.1
ROMMONA LC5     lc  rommonA 1.03  0.0  0.1
ROMMONB LC5     lc  rommon 1.03  0.0  0.1

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Can Bus Ctrl (CBC) LC5   lc  cbc  3.05  0.0  0.1
CPUCtrl LC5     lc  cpld1  0.15  0.0  0.1
QFPCPUBridge LC5 lc  fpga2  5.14  0.0  0.1
NPUXBarBridge LC5 lc  fpga1  0.22  0.0  0.1
ROMMONA LC5     lc  rommonA 1.03  0.0  0.1
ROMMONB LC5     lc  rommon 1.03  0.0  0.1

A9K-RSP-2G
Can Bus Ctrl (CBC) RSP2 lc  cbc  1.02  0.0  0.1
CPUCtrl RSP2    lc  cpld2  1.17  0.0  0.1
IntCtrl RSP2    lc  fpga2  1.15  0.0  0.1
ClkCtrl RSP2    lc  fpga3  1.23  0.0  0.1
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PUNT RSP2       lc  fpga1  1.05  0.0  0.1
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Cisco ASR 9000 Series Aggregation Services Router System Management Configuration Guide, Release 5.1.x
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<th>Device</th>
<th>Version</th>
<th>Link</th>
<th>Status</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A9K-RSP-4G</td>
<td>Can Bus Ctrl (CBC)</td>
<td>RSP2</td>
<td>lc cbc</td>
<td>1.02</td>
<td>0.0</td>
<td>0.1</td>
</tr>
<tr>
<td>A9K-RSP-8G</td>
<td>Can Bus Ctrl (CBC)</td>
<td>RSP2</td>
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</tr>
<tr>
<td>A9K-BPID2-10-SLOT</td>
<td>Can Bus Ctrl (CBC)</td>
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<td>lc cbc</td>
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<tr>
<td>A9K-BPID2-6-SLOT</td>
<td>Can Bus Ctrl (CBC)</td>
<td>BP2</td>
<td>lc cbc</td>
<td>7.103</td>
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<td>A9K-ISM-100</td>
<td>Can Bus Ctrl (CBC)</td>
<td>LC6</td>
<td>lc cbc</td>
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<td>A9K-8T-B</td>
<td>Can Bus Ctrl (CBC)</td>
<td>LC3</td>
<td>lc cpld1</td>
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<td>0.0</td>
<td>0.1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>lc fpga2</td>
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<td>lc fpga1</td>
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<td>lc rommonA</td>
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<td>0.1</td>
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<td></td>
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<td>0.1</td>
</tr>
<tr>
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<td>lc rommon</td>
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<td>0.1</td>
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<td>lc fpga1</td>
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<td>0.1</td>
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</table>

**show fpd package Command Output: Example**

```
---
A9K-RSP-4G Can Bus Ctrl (CBC) RSP2 lc cbc 1.02 0.0 0.1
CPUCtrl RSP2 lc cpld2 1.17 0.0 0.1
IntCtrl RSP2 lc fpga2 1.15 0.0 0.1
ClkCtrl RSP2 lc fpga3 1.23 0.0 0.1
UTI RSP2 lc fpga4 3.08 0.0 0.1
PUNT RSP2 lc fpga1 1.05 0.0 0.1
HSBI RSP2 lc hsbi 4.00 0.0 0.1
ROMMONA RSP2 lc rommonA 1.05 0.0 0.1
ROMMONB RSP2 lc rommon 1.05 0.0 0.1
---
A9K-RSP-8G Can Bus Ctrl (CBC) RSP2 lc cbc 1.02 0.0 0.1
CPUCtrl RSP2 lc cpld2 1.17 0.0 0.1
IntCtrl RSP2 lc fpga2 1.15 0.0 0.1
ClkCtrl RSP2 lc fpga3 1.23 0.0 0.1
UTI RSP2 lc fpga4 3.08 0.0 0.1
PUNT RSP2 lc fpga1 1.05 0.0 0.1
HSBI RSP2 lc hsbi 4.00 0.0 0.1
ROMMONA RSP2 lc rommonA 1.05 0.0 0.1
ROMMONB RSP2 lc rommon 1.05 0.0 0.1
---
ASR-9010-FAN Can Bus Ctrl (CBC) FAN lc cbc 4.00 0.0 0.1
---
ASR-9006-FAN Can Bus Ctrl (CBC) FAN lc cbc 5.00 0.0 0.1
---
A9K-BPID2-10-SLOT Can Bus Ctrl (CBC) BP2 lc cbc 7.103 0.0 0.1
---
A9K-BPID2-6-SLOT Can Bus Ctrl (CBC) BP2 lc cbc 7.103 0.0 0.1
---
A9K-8T-B Can Bus Ctrl (CBC) LC3 lc cpld1 1.02 0.0 0.1
PHYCtrl LC3 lc cpld2 0.08 0.0 0.1
DB CPUCtrl LC3 lc cpld4 1.03 0.0 0.1
PortCtrl LC3 lc fpga2 0.11 0.0 0.1
Raven LC3 lc fpga1 1.02 0.0 0.1
---
```
<table>
<thead>
<tr>
<th>Model</th>
<th>Description</th>
<th>Vendor</th>
<th>Version</th>
<th>Type</th>
<th>Status</th>
</tr>
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<td>0.1</td>
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<td>fpga1</td>
<td>1.01</td>
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<td>0.0</td>
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<td>rommon</td>
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<td>0.0</td>
</tr>
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<td>SPA E3 Subrate FPGA</td>
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<td>fpga1</td>
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<td>0.0</td>
</tr>
<tr>
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<td>spa</td>
<td>rommon</td>
<td>2.12</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
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<td>0.100</td>
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<td>fpga2</td>
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<td>0.200</td>
</tr>
<tr>
<td>SPA I/O FPGA</td>
<td>spa</td>
<td>fpga1</td>
<td>2.08</td>
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<td>0.100</td>
</tr>
<tr>
<td>SPA ROMMON</td>
<td>spa</td>
<td>rommon</td>
<td>2.12</td>
<td>0.0</td>
<td>0.100</td>
</tr>
<tr>
<td>SPA-2XCT3/DS0</td>
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<td>spa</td>
<td>0.11</td>
<td>0.0</td>
<td>0.100</td>
</tr>
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<td>fpga2</td>
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<td>0.0</td>
<td>0.200</td>
</tr>
<tr>
<td>SPA I/O FPGA</td>
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<td>fpga1</td>
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<td>0.100</td>
</tr>
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<td>rommon</td>
<td>2.12</td>
<td>0.0</td>
<td>0.100</td>
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<td>spa</td>
<td>1.04</td>
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<td>0.0</td>
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<td>SPA I/O FPGA</td>
<td>spa</td>
<td>fpga1</td>
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<td>0.0</td>
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<td>spa</td>
<td>rommon</td>
<td>2.12</td>
<td>0.0</td>
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<td>SPA I/O FPGA</td>
<td>spa</td>
<td>fpga1</td>
<td>1.36</td>
<td>0.0</td>
<td>0.49</td>
</tr>
<tr>
<td>SPA ROMMON</td>
<td>spa</td>
<td>rommon</td>
<td>2.02</td>
<td>0.0</td>
<td>0.49</td>
</tr>
<tr>
<td>SPA-2XCHOC12/DS0</td>
<td>SPA FPGA2 swv1.00</td>
<td>spa</td>
<td>1.00</td>
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<td>SPA FPGA swv1.36</td>
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<td>fpga1</td>
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<td>SPA ROMMON swv2.2</td>
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</table>
This table describes the significant fields shown in the display:

**Table 23: show fpd package Field Descriptions**

<table>
<thead>
<tr>
<th>Field</th>
<th>Description</th>
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<tbody>
<tr>
<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 upgrade <code>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>
<tr>
<td>Min Req HW Vers</td>
<td>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.</td>
</tr>
</tbody>
</table>
This example shows the output display for ASR9912 and ASR9922:

```
RP/0/RSP0/CPU0:router # show fpd package
```

<table>
<thead>
<tr>
<th>Card Type</th>
<th>FPD Description</th>
<th>Type</th>
<th>Subtype</th>
<th>Version</th>
<th>Min Req SW Ver</th>
<th>Min Req HW Ver</th>
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</thead>
<tbody>
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<td>ASR-9912-BPID2</td>
<td>Can Bus Ctrl (CBC) BP2</td>
<td>bp</td>
<td>cbc</td>
<td>7.104</td>
<td>0.00</td>
<td>0.1</td>
</tr>
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<td>Can Bus Ctrl (CBC) BP2</td>
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<td>cbc</td>
<td>7.104</td>
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<td>Can Bus Ctrl (CBC) BP2</td>
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<td>cbc</td>
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<td>Can Bus Ctrl (CBC) BP2</td>
<td>bp</td>
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<td>7.104</td>
<td>0.00</td>
<td>0.1</td>
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<td>Can Bus Ctrl (CBC) BP2</td>
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<td>cbc</td>
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</tr>
<tr>
<td>A9K-BPID2-6-SLOT</td>
<td>Can Bus Ctrl (CBC) BP2</td>
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<td>cbc</td>
<td>7.104</td>
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<td>0.1</td>
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<td>cbc</td>
<td>7.104</td>
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</tr>
<tr>
<td>ASR-9922-SFC110</td>
<td>Can Bus Ctrl (CBC) MTFC</td>
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<td>cbc</td>
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<td></td>
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<td>cbc</td>
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<tr>
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<td>fc fpga7</td>
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<tr>
<td>ASR-9010-FAN</td>
<td>Can Bus Ctrl (CBC) FAN</td>
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<td>cbc</td>
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<td>Can Bus Ctrl (CBC) FAN</td>
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<td>cbc</td>
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<td>cbc</td>
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<td>0.1</td>
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<td>cpdl 2</td>
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<td>fpga2</td>
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<td>------------------------</td>
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<td>--------</td>
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<td>-------</td>
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Cisco ASR 9000 Series Aggregation Services Router System Management Configuration Guide, Release 5.1.x
### show fpd package Command Output: Example

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### Upgrading FPD

**Cisco ASR 9000 Series Aggregation Services Router System Management Configuration Guide, Release 5.1.x**

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show fpd package Command Output: Example

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show fpd package Command Output: Example

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<td>0.00</td>
</tr>
<tr>
<td>SPA-8XCHT1/E1</td>
<td>SPA I/O FPGA</td>
<td>spa</td>
<td>fpga1</td>
<td>2.08</td>
<td>0.00</td>
</tr>
<tr>
<td>SPA-ROMMON</td>
<td>spa ROMMON</td>
<td>spa</td>
<td>rommon</td>
<td>2.12</td>
<td>0.00</td>
</tr>
<tr>
<td>SPA-OC192POS-XFP</td>
<td>SPA FPGA</td>
<td>swv1.2</td>
<td>spa fpga1</td>
<td>1.02</td>
<td>0.00</td>
</tr>
<tr>
<td>SPA-2XOC48POS/RPR</td>
<td>SPA FPGA</td>
<td>swv1.0</td>
<td>spa fpga1</td>
<td>1.00</td>
<td>0.00</td>
</tr>
<tr>
<td>SPA-4XOC48POS/RPR</td>
<td>SPA FPGA</td>
<td>swv1.0</td>
<td>spa fpga1</td>
<td>1.00</td>
<td>0.00</td>
</tr>
<tr>
<td>SPA-8XOC3-POS</td>
<td>SPA FPGA</td>
<td>swv1.0</td>
<td>spa fpga1</td>
<td>1.00</td>
<td>0.00</td>
</tr>
<tr>
<td>SPA-2XOC12-POS</td>
<td>SPA FPGA</td>
<td>swv1.0</td>
<td>spa fpga1</td>
<td>1.00</td>
<td>0.00</td>
</tr>
<tr>
<td>SPA-4XOC12-POS</td>
<td>SPA FPGA</td>
<td>swv1.0</td>
<td>spa fpga1</td>
<td>1.00</td>
<td>0.00</td>
</tr>
<tr>
<td>SPA-10X1GE-V2</td>
<td>SPA FPGA</td>
<td>swv1.10</td>
<td>spa fpga1</td>
<td>1.10</td>
<td>0.00</td>
</tr>
<tr>
<td>SPA-5X1GE-V2</td>
<td>SPA FPGA</td>
<td>swv1.10</td>
<td>spa fpga1</td>
<td>1.10</td>
<td>0.00</td>
</tr>
<tr>
<td>SPA-1X10GE-L-V2</td>
<td>SPA FPGA</td>
<td>swv1.9</td>
<td>spa fpga1</td>
<td>1.09</td>
<td>0.00</td>
</tr>
<tr>
<td>SPA-4XOC3-POS-V2</td>
<td>SPA FPGA</td>
<td>swv1.0</td>
<td>spa fpga1</td>
<td>1.00</td>
<td>0.00</td>
</tr>
<tr>
<td>SPA-1X10GE-WL-V2</td>
<td>SPA FPGA</td>
<td>swv1.9</td>
<td>spa fpga1</td>
<td>1.09</td>
<td>0.00</td>
</tr>
<tr>
<td>SPA-1XOC3-ATM-V2</td>
<td>SPA FPGA</td>
<td>swv1.2</td>
<td>spa fpga1</td>
<td>2.02</td>
<td>0.00</td>
</tr>
<tr>
<td>SPA-2XOC3-ATM-V2</td>
<td>SPA FPGA</td>
<td>swv1.2</td>
<td>spa fpga1</td>
<td>2.02</td>
<td>0.00</td>
</tr>
<tr>
<td>SPA-3XOC3-ATM-V2</td>
<td>SPA FPGA</td>
<td>swv1.2</td>
<td>spa fpga1</td>
<td>2.02</td>
<td>0.00</td>
</tr>
<tr>
<td>SPA-1XOC12-ATM-V2</td>
<td>SPA FPGA</td>
<td>swv1.2</td>
<td>spa fpga1</td>
<td>2.02</td>
<td>0.00</td>
</tr>
</tbody>
</table>

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:

<table>
<thead>
<tr>
<th>Location</th>
<th>Type</th>
<th>Subtype</th>
<th>Upg/Dng</th>
<th>Current Version</th>
<th>Upg/Dng Version</th>
</tr>
</thead>
<tbody>
<tr>
<td>0/1/cpu0</td>
<td>lc</td>
<td>fpga</td>
<td>upg</td>
<td>0.40</td>
<td>0.40</td>
</tr>
</tbody>
</table>

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
SF/0/1/SP:Jan 12 05:44:41.150 : upgrade_daemon[280]: programming...with file
/net/node0_RPI_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 : ingressq[179]: EES:Internal clock detect IDLE period(-105945) more than threshold(1200000)
LC/0/1/CPU0:Jan 12 05:45:09.241 : ingressq[179]: EES:Internal clock detect IDLE period(-105944) more than threshold(1200000)
SF/0/1/SP:Jan 12 05:45:16.020 : upgrade_daemon[280]: ...programming...
SF/0/1/SP:Jan 12 05:45:16.034 : upgrade_daemon[280]: ...it will take a while...
SF/0/1/SP:Jan 12 05:45:16.053 : upgrade_daemon[280]: ...it will take a while...
SF/0/1/SP:Jan 12 05:47:42.967 : upgrade_daemon[280]: ...programming...
SF/0/1/SP: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 :

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:router# show platform
Sat Jul 25 12:26:30.905 DST
Node Type State Config State
-----------------------------------------------
0/RSP0/CPU0 A9K-RSP-4G(Active) IOS XR RUN PWR,NSSHUT,MON
0/FT0/SP FAN TRAY READY
0/FT1/SP FAN TRAY READY
```
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 08:23:32.593 : spa_192_jacket[188]: %L2-SPA-5-OIR_ERROR : SPA (0): Too many retries, error recovery stopped

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 fpd` 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 shut down 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# hw-module reset auto disable location 0/1/4
```

### Additional References

The following sections provide references related to FPD software upgrade.

#### Related Documents

<table>
<thead>
<tr>
<th>Related Topic</th>
<th>Document Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cisco IOS XR command master list</td>
<td><em>Cisco ASR 9000 Series Aggregation Services Router Commands Master List</em></td>
</tr>
<tr>
<td>Cisco IOS XR FPD upgrade-related commands</td>
<td><em>Cisco ASR 9000 Series Aggregation Services Router System Management Command Reference</em></td>
</tr>
<tr>
<td>Initial system startup and configuration information for a router using the Cisco IOS XR Software.</td>
<td><em>Cisco ASR 9000 Series Aggregation Services Router Getting Started Guide</em></td>
</tr>
<tr>
<td>Information about user groups and task IDs</td>
<td><em>Configuring AAA Services on the Cisco ASR 9000 Series Router module of Cisco ASR 9000 Series Aggregation Services Router System Security Configuration Guide</em></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>There are no applicable MIBs for this module.</td>
<td>To locate and download MIBs for selected platforms using Cisco IOS XR Software, use the Cisco MIB Locator found at the following URL: <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>
Configuring Frequency Synchronization

Frequency Synchronization is used to distribute precision frequency around a network. This module describes the tasks required to configure frequency synchronization on the Cisco IOS XR software.

For more information about frequency synchronization on the Cisco IOS XR software and complete descriptions of the commands listed in this module, see Additional References. 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>
<thead>
<tr>
<th>Release</th>
<th>Modification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Release 3.9.0</td>
<td>This feature was introduced.</td>
</tr>
<tr>
<td>Release 5.3.0</td>
<td>Support introduced for nV Cluster Clocking.</td>
</tr>
</tbody>
</table>

This module contains the following topics:

- Information About Frequency Synchronization, page 191
- Configuring Frequency Synchronization, page 193

Information About Frequency Synchronization

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 and SONET equipment. This is used in conjunction with an external timing technology (such as Cesium oscillators or GPS) to provide synchronization of precision timing across the network. As, increasingly, SDH and SONET equipment is replaced by Ethernet equipment this frequency synchronization ability is required over Ethernet ports.
Frequency Synchronization Timing Concepts

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

Sources

A source is a piece of hardware that inputs frequency signals into the system or transmits them out of the system. There are four types of sources:

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

Selection Points

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

The input signals to the selection points can be:

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

Note that the output of a selection point can be used in a number of ways:
• To drive the signals sent out of a set of sources.
• As input into another selection point on the card.
• As input into a selection point on another card.

Use the `show frequency synchronization selection` command to see a detailed view of the different selection points within the system.

### 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> configure</td>
<td></td>
</tr>
<tr>
<td><strong>Step 2</strong> frequency synchronization</td>
<td>Enables frequency synchronization on the router.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>RP/0/RSP0/CPU0:router(config)# frequency synchronization</td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong> clock-interface timing-mode {independent</td>
<td>(Optional) Configures the type of timing sources that can be used to drive system}</td>
</tr>
</tbody>
</table>
### Enabling Frequency Synchronization on the Router

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td><code>RP/0/RSP0/CPU0:router(config-freqsync)#</code></td>
<td>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><code>clock-interface</code></td>
<td>- <strong>independent</strong>—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>
<tr>
<td><code>timing-mode system</code></td>
<td>- <strong>system</strong>—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 interfaces), including clock interfaces. Loopback detection is disabled.</td>
</tr>
</tbody>
</table>

#### Step 4

**quality itu-t option {1 | 2 generation {1 | 2}}**  
(Optional) Specifies the quality level for the router. The default is **option 1**.

**Example:**  
```
RP/0/RSP0/CPU0:router(config-freqsync)#
quality itu-t
option 2 generation 1
```

- **option 1**—Includes PRC, SSU-A, SSU-B, SEC and DNU.  
- **option 2 generation 1**—Includes PRS, STU, ST2, ST3, SMC, ST4, RES and DUS.  
- **option 2 generation 2**—Includes PRS, STU, ST2, ST3, TNC, ST3E, SMC, ST4, PROV and DUS.  

**Note**  
The quality option configured here must match the quality option specified in the **quality receive** and **quality transmit** commands in interface frequency synchronization configuration mode.

#### Step 5

**log selection {changes | errors}**  
Enables logging to frequency synchronization.

**Example:**  
```
RP/0/RSP0/CPU0:router(config-freqsync)#
log selection changes
```

- **changes**—Logs every time there is a change to the selected source, in addition to errors.  
- **errors**—Logs only when there are no available frequency sources, or when the only available frequency source is the internal oscillator.

#### Step 6

Use one of these commands:  
- **end**  
- **commit**

**Example:**  
```
RP/0/RSP0/CPU0:router(config-freqsync)#
end
or
RP/0/RSP0/CPU0:router(config-freqsync)#
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.
<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>•Entering cancels leaves the router in the current configuration session without exiting or committing the configuration changes.</td>
<td></td>
</tr>
<tr>
<td>•Use the commit command to save the configuration changes to the running configuration file, and remain within the configuration session.</td>
<td></td>
</tr>
</tbody>
</table>

**What to Do Next**

Configure frequency synchronization on any interfaces that should participate in frequency synchronization.

**Related Topics**

- Configuring Frequency Synchronization on an Interface, on page 195

**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><strong>Step 1</strong> configure</td>
<td>Enters interface configuration mode.</td>
</tr>
<tr>
<td><strong>Step 2</strong> 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><strong>Example:</strong></td>
<td>Rp/0/RSP0/CPU0:router(config)# interface GigabitEthernet0/1/1/0</td>
</tr>
<tr>
<td><strong>Step 3</strong> frequency synchronization</td>
<td>(Optional) Specifies the interface as a timing source to be passed to the selection algorithm.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>Rp/0/RSP0/CPU0:router(config-if)# frequency synchronization</td>
</tr>
<tr>
<td><strong>Step 4</strong> 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><strong>Example:</strong></td>
<td>Rp/0/RSP0/CPU0:router(config-if-freqsync)# selection input</td>
</tr>
<tr>
<td><strong>Step 5</strong> priority priority-value</td>
<td>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><strong>Example:</strong></td>
<td>Rp/0/RSP0/CPU0:router(config-if-freqsync)# priority 100</td>
</tr>
<tr>
<td><strong>Step 6</strong> wait-to-restore minutes</td>
<td>(Optional) Enables Synchronization Status Messages (SSMs) on the interface.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>Rp/0/RSP0/CPU0:router(config-if-freqsync)# wait-to-restore 300</td>
</tr>
<tr>
<td><strong>Step 7</strong> ssm disable</td>
<td>(Optional) Adjusts the QL that is transmitted in SSMs.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>Rp/0/RSP0/CPU0:router(config-if-freqsync)# ssm disable</td>
</tr>
<tr>
<td><strong>Step 8</strong> time-of-day-priority priority</td>
<td>For SyncE interfaces, this disables sending ESMC packets, and ignores any received ESMC packets. For SONET and clock interfaces, this causes DNUstosent, and ignores any received QL value.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>Rp/0/RSP0/CPU0:router(config-if-freqsync)# time-of-day-priority 50</td>
</tr>
<tr>
<td><strong>Step 9</strong> quality transmit {exact</td>
<td>highest</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>Rp/0/RSP0/CPU0:router(config-if-freqsync)# time-of-day-priority 50</td>
</tr>
</tbody>
</table>
### Configuring Frequency Synchronization on an Interface

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
</table>
| **Example:** RP/0/RSP0/CPU0:router(config-clk-freqsync)# quality transmit highest itu-t option 1 prc | • **exact ql**—Specifies the exact QL to send, unless DNU would otherwise be sent.  
• **highest ql**—Specifies an upper limit on the QL to be sent. If the selected source has a higher QL than the QL specified here, this QL is sent instead.  
• **lowest ql**—Specifies a lower limit on the QL to be sent. If the selected source has a lower QL than the QL specified here, DNU is sent instead.  

The quality option specified in this command must match the globally-configured quality option in the **quality itu-t option** command.  
**Note** For clock interfaces that do not support SSM, only the lowest QL can be specified. In this case, rather than sending DNU, the output is squelched, and no signal is sent. |

### Step 10

**quality receive {exact | highest | lowest} itu-t option ql-option**

**Example:** RP/0/RSP0/CPU0:router(config-clk-freqsync)# quality receive highest itu-t option 1 prc  
(Optional) Adjusts the QL value that is received in SSMS, before it is used in the selection algorithm.  
• **exact ql**—Specifies the exact QL regardless of the value received, unless the received value is DNU.  
• **highest ql**—Specifies an upper limit on the received QL. If the received value is higher than this specified QL, this QL is used instead.  
• **lowest ql**—Specifies a lower limit on the received QL. If the received value is lower than this specified QL, DNU is used instead.  

The quality option specified in this command must match the globally-configured quality option in the **quality itu-t option** command.  
**Note** For clock interfaces that do not support SSM, only the exact QL can be specified. |

### Step 11

Use one of these commands:  
• **end**  
• **commit**

**Example:** RP/0/RSP0/CPU0:router(config-if-freqsync)# end  
Saves configuration changes.  
• When you issue the **end** command, the system prompts you to commit changes:  

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

• Entering yes saves configuration changes to the running configuration file, exits the configuration session, and returns the router to EXEC mode.
<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
</table>
| or                | • Entering no exits the configuration session and returns the router to EXEC mode without committing the configuration changes.  
| RP/0/RSP0/CPU0:router(config-if-freqsync)# commit |  
|                   | • 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. |

Related Topics

Enabling Frequency Synchronization on the Router, on page 193

Configuring Frequency Synchronization on a Clock Interface

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

Note

The configuration on clock interfaces must be the same for corresponding clock interfaces across all RSPs to avoid changes in frequency synchronization behavior in the event of an RSP switchover.
SUMMARY STEPS

1. configure
2. clock-interface sync port-no location node-id
3. port-parameters {bits-input mode | bits-output mode | dti}
4. ics
5. frequency synchronization
6. selection input
7. priority priority-value
8. wait-to-restore minutes
9. ssm disable
10. time-of-day-priority priority
11. quality transmit {exact | highest | lowest} itu-t option ql-option
12. quality receive {exact | highest | lowest} itu-t option ql-option
13. 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>Enters clock interface configuration mode to configure the clock interface.</td>
</tr>
<tr>
<td>Step 2 clock-interface sync port-no location node-id</td>
<td>Specifies the type of external clock source for the clock interface. Options are BITS RX, BITS TX or DTI. The possible mode values for BITS interfaces are 2m, 6m-output-only, e1 or t1.</td>
</tr>
</tbody>
</table>
| Example:          | RP/0/RSP0/CPU0:router(config) #
|                   | clock-interface sync 2 location 0/2/0 |
| Step 3 port-parameters {bits-input mode | bits-output mode | dti} | Enables chassis synchronization. |
| Example:          | RP/0/RSP0/CPU0:router(config-clock-if) #
<p>|                   | port-parameters dti |
| Step 4 ics        | Enters clock interface frequency synchronization mode to configure frequency synchronization parameters. |
| Example:          | RP/0/RSP0/CPU0:router(config) # ics |
| Step 5 frequency synchronization | The remaining steps in this task are the same as those used to configure the interface frequency synchronization. |</p>
<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 6</strong> selection input</td>
<td>(Optional) Specifies the interface as a timing source to be passed to the selection algorithm.</td>
</tr>
<tr>
<td>Example: RP/0/RSP0/CPU0:router(config-if-freqsync)# selection input</td>
<td></td>
</tr>
<tr>
<td><strong>Step 7</strong> priority priority-value</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>Example: RP/0/RSP0/CPU0:router(config-if-freqsync)# priority 100</td>
<td></td>
</tr>
<tr>
<td><strong>Step 8</strong> 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><strong>Step 9</strong> ssm disable</td>
<td>(Optional) Disables Synchronization Status Messages (SSMs) on the interface.</td>
</tr>
</tbody>
</table>
| Example: RP/0/RSP0/CPU0:router(config-if-freqsync)# ssm disable | - 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. |
| **Step 10** time-of-day-priority priority | (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. |
| Example: RP/0/RSP0/CPU0:router(config-if-freqsync)# time-of-day-priority 50 | |
| **Step 11** quality transmit {exact | highest | lowest} itu-t option ql-option | (Optional) Adjusts the QL that is transmitted in SSMs. |
| Example: RP/0/RSP0/CPU0:router(config-clk-freqsync)# quality transmit highest itu-t option 1 prc | - **exact ql**—Specifies the exact QL to send, unless DNU would otherwise be sent.  
- **highest ql**—Specifies an upper limit on the QL to be sent. If the selected source has a higher QL than the QL specified here, this QL is sent instead.  
- **lowest ql**—Specifies a lower limit on the QL to be sent. If the selected source has a lower QL than the QL specified here, DNU is sent instead. |
| The quality option specified in this command must match the globally-configured quality option in the **quality itu-t option** command. |
### Command or Action

<table>
<thead>
<tr>
<th>Command</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 12</strong></td>
<td>quality receive {exact</td>
</tr>
<tr>
<td><strong>Step 13</strong></td>
<td>Use one of these commands:</td>
</tr>
</tbody>
</table>

**Note** For clock interfaces that do not support SSM, only the lowest QL can be specified. In this case, rather than sending DNU, the output is squelched, and no signal is sent.

**Example:**

```
RP/0/RSP0/CPU0:router(config-clk-freqsync)#
quality receive highest itu-t option 1 prc
```

(Optional) Adjusts the QL value that is received in SSMs, before it is used in the selection algorithm.

- **exact ql**—Specifies the exact QL regardless of the value received, unless the received value is DNU.
- **highest ql**—Specifies an upper limit on the received QL. If the received value is higher than this specified QL, this QL is used instead.
- **lowest ql**—Specifies a lower limit on the received QL. If the received value is lower than this specified QL, DNU is used instead.

The quality option specified in this command must match the globally-configured quality option in the `quality itu-t option` command.

**Note** For clock interfaces that do not support SSM, only the exact QL can be specified.

**Step 13** | Use one of these commands: |

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

**Example:**

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

Saves configuration changes.

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

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

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

  - Use the `commit` command to save the configuration changes to the running configuration file, and remain within the configuration session.
Verifying the 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 GigabitEthernet0/2/0/0 frequency synchronization quality transmit exact itu-t option 2
generation 1 PRS  
 * The QL that is configured is from a different QL option set than is configured globally.
```

Displays any errors that are caused by inconsistencies between shared-plane (global) and local-plane (interface) configurations. There are two possible errors that can be displayed:

- Frequency Synchronization is configured on an interface (line interface or clock-interface), but is not configured globally. Refer to Enabling Frequency Synchronization on the Router, on page 193
- 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

Fl  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
```

Cisco ASR 9000 Series Aggregation Services Router System Management Configuration Guide, Release 5.1.x
Verifying the Frequency Synchronization Configuration

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-I/PRC  
  Effective QL: Opt-I/PRC  
  Next selection points: LC_INGRESS

RP/0/RSP0/CPU0:router# show frequency synchronization clock-interfaces location 0/1/CPU0

Node 0/1/CPU0:  
-------------------
Fl Clock Interface QLrcv QLuse Pri QLsnd Source  
------------------- ------------------- --- ---- --- -------------------  
D Sync0 None Fail 100 SSU-B Internal0 [0/1/CPU0]  
D Sync1 None Fail 100 SSU-B Internal0 [0/1/CPU0]  
>S Internal10 n/a SSU-B 255 n/a None
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
```

Verifies that the fsyncmgr process is running on the appropriate nodes.
Additional References

The following sections provide references related to Implementing frequency synchronization 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 frequency synchronization commands</td>
<td>Frequency Synchronization Commands on the Cisco ASR 9000 Series Router module of Cisco ASR 9000 Series Aggregation Services Router System Management Command Reference</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 Cisco ASR 9000 Series Aggregation Services Router System Security Configuration Guide</td>
</tr>
</tbody>
</table>

### Standards and RFCs

<table>
<thead>
<tr>
<th>Standard/RFC</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>ITU-T Recommendation G.781</td>
<td>Synchronization layer functions</td>
</tr>
<tr>
<td>ITU-T Recommendation G.8261</td>
<td>Timing and Synchronization aspects in Packet Networks</td>
</tr>
<tr>
<td>ITU-T Recommendation G.8264</td>
<td>Distribution of Timing through packet networks</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 for selected platforms, Cisco IOS releases, and feature sets, use Cisco MIB Locator found at the following URL: <a href="http://www.cisco.com/go/mibs">http://www.cisco.com/go/mibs</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. 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. 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>
Implementing NTP

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 230. 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 25: 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, page 208
- Information About Implementing NTP, page 208
- How to Implement NTP, page 209
- Configuration Examples for Implementing NTP, page 226
- Configuring NTP server inside VRF interface, page 228
- Additional References, page 230
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 222

**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> configure</td>
<td></td>
</tr>
<tr>
<td><strong>Step 2</strong> ntp</td>
<td>Enters NTP configuration mode.</td>
</tr>
<tr>
<td>Example: <code>RP/0/RSP0/CPU0:router(config)# ntp</code></td>
<td></td>
</tr>
</tbody>
</table>
## Configuring Poll-Based Associations

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 3</strong> server ip-address [version number] [key key-id] [minpoll interval] [maxpoll interval] [source type interface-path-id] [prefer] [burst] [iburst]</td>
<td>Forms a server association with another system. This step can be repeated as necessary to form associations with multiple devices.</td>
</tr>
<tr>
<td><strong>Example:</strong> RP/0/RSP0/CPU0:router(config-ntp)# server 172.16.22.44 minpoll 8 maxpoll 12</td>
<td></td>
</tr>
<tr>
<td><strong>Step 4</strong> peer ip-address [version number] [key key-id] [minpoll interval] [maxpoll interval] [source type interface-path-id] [prefer]</td>
<td>Forms a peer association with another system. This step can be repeated as necessary to form associations with multiple systems.</td>
</tr>
<tr>
<td><strong>Note</strong> To complete the configuration of a peer-to-peer association between the router and the remote device, the router must also be configured as a peer on the remote device.</td>
<td></td>
</tr>
<tr>
<td><strong>Example:</strong> RP/0/RSP0/CPU0:router(config-ntp)# peer 192.168.22.33 minpoll 8 maxpoll 12 source tengige 0/0/0/1</td>
<td></td>
</tr>
<tr>
<td><strong>Step 5</strong> Use one of the following commands: • end • commit</td>
<td>Saves configuration changes.</td>
</tr>
<tr>
<td><strong>Example:</strong> RP/0/RSP0/CPU0:router(config-ntp)# end or RP/0/RSP0/CPU0:router(config-ntp)# commit</td>
<td>• When you issue the <strong>end</strong> 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 <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></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></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 <strong>commit</strong> command to save the configuration changes to the running configuration file and remain within the configuration session.</td>
</tr>
</tbody>
</table>
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.

---

### SUMMARY STEPS

1. `configure`
2. `ntp`
3. (Optional) `broadcastdelay micro.seconds`
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></td>
<td><code>configure</code></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>
</tbody>
</table>
### Configuring Broadcast-Based NTP Associates

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 3</strong></td>
<td>broadcastdelay microseconds</td>
</tr>
<tr>
<td>Example:</td>
<td>RP/0/RSP0/CPU0:router(config-ntp)# broadcastdelay 5000</td>
</tr>
<tr>
<td><strong>Step 4</strong></td>
<td>interface type interface-path-id</td>
</tr>
<tr>
<td>Example:</td>
<td>RP/0/RSP0/CPU0:router(config-ntp)# interface POS 0/1/0/0</td>
</tr>
<tr>
<td><strong>Step 5</strong></td>
<td>broadcast client</td>
</tr>
<tr>
<td>Example:</td>
<td>RP/0/RSP0/CPU0:router(config-ntp-int)# broadcast client</td>
</tr>
<tr>
<td><strong>Step 6</strong></td>
<td>broadcast [destination ip-address] [key key-id] [version number]</td>
</tr>
<tr>
<td>Example:</td>
<td>RP/0/RSP0/CPU0:router(config-ntp-int)# broadcast destination 10.50.32.149</td>
</tr>
<tr>
<td><strong>Step 7</strong></td>
<td>Use one of the following commands:</td>
</tr>
<tr>
<td></td>
<td>• end</td>
</tr>
<tr>
<td></td>
<td>• commit</td>
</tr>
<tr>
<td>Example:</td>
<td>RP/0/RSP0/CPU0:router(config-ntp-int)# end</td>
</tr>
<tr>
<td></td>
<td>RP/0/RSP0/CPU0:router(config-ntp-int)# commit</td>
</tr>
</tbody>
</table>

**Note:** Go to Step 6, on page 213 to configure the interface to receive NTP broadcast packets.

**Note:** Go to Step 5, on page 213 to configure the interface to send NTP broadcast packets.

**Note:** Go to Step 5, on page 213 to configure the interface to send NTP broadcast packets.

Saves configuration changes.

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

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

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

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

**Note**

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

The access list-based restriction scheme allows you to grant or deny certain access privileges to an entire network, a subnet within a network, or a host within a subnet.

The access group options are scanned in the following order, from least restrictive to most restrictive:

1. **peer**—Allows time requests and NTP control queries and allows the system to synchronize itself to a system whose address passes the access list criteria.
2. **serve**—Allows time requests and NTP control queries, but does not allow the system to synchronize itself to a system whose address passes the access list criteria.
3. **serve-only**—Allows only time requests from a system whose address passes the access list criteria.
4. **query-only**—Allows only NTP control queries from a system whose address passes the access list criteria.

If the source IP address matches the access lists for more than one access type, the first type is granted. If no access groups are specified, all access types are granted to all systems. If any access groups are specified, only the specified access types are granted.

For details on NTP control queries, see RFC 1305 (NTP version 3).

**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>Step 1 configure</td>
<td></td>
</tr>
</tbody>
</table>
Configuring NTP Authentication

This task explains how to configure NTP authentication.

Note

No specific command enables NTP; the first NTP configuration command that you issue enables NTP.
The encrypted NTP authentication scheme should be used when a reliable form of access control is required. Unlike the access-list-based restriction scheme that is based on IP addresses, the encrypted authentication scheme uses authentication keys and an authentication process to determine if NTP synchronization packets sent by designated peers or servers on a local network are deemed as trusted, before the time information that it carries along is accepted.

The authentication process begins from the moment an NTP packet is created. A message authentication code (MAC) is computed using the MD5 Message Digest Algorithm and the MAC is embedded into an NTP synchronization packet. The NTP synchronization packet together with the embedded MAC and key number are transmitted to the receiving client. If authentication is enabled and the key is trusted, the receiving client computes the MAC in the same way. If the computed MAC matches the embedded MAC, the system is allowed to sync to the server that uses this key in its packets.

After NTP authentication is properly configured, your networking device only synchronizes with and provides synchronization to trusted time sources.

**SUMMARY STEPS**

1. configure
2. ntp
3. authenticate
4. authentication-key key-number md5 [clear | encrypted] key-name
5. trusted-key key-number
6. Use one of the following commands:
   - end
   - commit

**DETAILED STEPS**

<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>Enables the NTP authentication feature.</td>
</tr>
<tr>
<td>Example: RP/0/RSP0/CPU0:router(config)# ntp</td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong> authenticate</td>
<td>Defines the authentication keys.</td>
</tr>
<tr>
<td>Example: RP/0/RSP0/CPU0:router(config-ntp)# authenticate</td>
<td>- Each key has a key number, a type, a value, and, optionally, a name. Currently the only key type supported is md5.</td>
</tr>
<tr>
<td><strong>Step 4</strong> authentication-key key-number md5 [clear</td>
<td>encrypted] key-name</td>
</tr>
</tbody>
</table>

Cisco ASR 9000 Series Aggregation Services Router System Management Configuration Guide, Release 5.1.x
## Implementing NTP

### 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.

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Example:</strong> RP/0/RSP0/CPU0:router(config-ntp)# authentication-key 42 md5 clear key1</td>
<td>Defines trusted authentication keys.</td>
</tr>
<tr>
<td><strong>Step 5</strong> trusted-key <em>key-number</em></td>
<td>• If a key is trusted, this router only synchronizes to a system that uses this key in its NTP packets.</td>
</tr>
<tr>
<td><strong>Example:</strong> RP/0/RSP0/CPU0:router(config-ntp)# trusted-key 42</td>
<td>Saves configuration changes.</td>
</tr>
<tr>
<td><strong>Step 6</strong> Use one of the following commands: • end • commit</td>
<td>• When you issue the <strong>end</strong> command, the system prompts you to commit changes:</td>
</tr>
<tr>
<td><strong>Example:</strong> RP/0/RSP0/CPU0:router(config-ntp)# end or RP/0/RSP0/CPU0:router(config-ntp)# commit</td>
<td>Uncommitted changes found, commit them before exiting(yes/no/cancel)? [cancel]:</td>
</tr>
<tr>
<td></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></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></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 <strong>commit</strong> command to save the configuration changes to the running configuration file and remain within the configuration session.</td>
</tr>
</tbody>
</table>
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>
<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></td>
</tr>
<tr>
<td><strong>Step 3</strong></td>
<td>Use one of the following commands:</td>
</tr>
<tr>
<td>Example:</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>Example:</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]:

Cisco ASR 9000 Series Aggregation Services Router System Management Configuration Guide, Release 5.1.x
<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>or</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>RP/0/RSP0/CPU0:router(config-ntp)# commit</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></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 <strong>commit</strong> command to save the configuration changes to the running configuration file and remain within the configuration session.</td>
</tr>
</tbody>
</table>

### 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>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1 configure</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><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>( \text{Example:} \ RP/0/RSP0/CPU0:router(config-ntp)# master 9 )</td>
</tr>
<tr>
<td><strong>Step 3</strong> master stratum</td>
<td>Makes the router an authoritative NTP server.</td>
</tr>
<tr>
<td><strong>Example:</strong> RP/0/RSP0/CPU0:router(config-ntp)# master 9</td>
<td><strong>Note</strong> Use the <code>master</code> 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 <code>master</code> command can cause instability in time keeping if the machines do not agree on the time.</td>
</tr>
<tr>
<td><strong>Step 4</strong> Use one of the following commands:</td>
<td>Saves configuration changes.</td>
</tr>
<tr>
<td>• end</td>
<td>• When you issue the <code>end</code> command, the system prompts you to commit changes:</td>
</tr>
<tr>
<td>• commit</td>
<td>( \text{Uncommitted changes found, commit them before exiting(yes/no/cancel)?} )</td>
</tr>
<tr>
<td><strong>Example:</strong> RP/0/RSP0/CPU0:router(config-ntp)# end</td>
<td>• Entering <code>yes</code> 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 <code>no</code> 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-ntp)# commit</td>
<td>• Entering <code>cancel</code> leaves the router in the current configuration session without exiting or committing the configuration changes.</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 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
!% 'ip-ntp' detected the 'fatal' condition 'PTP is not supported on this platform'
end

Refer to the Configuring PTP, on page 233 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>Step 1 configure</td>
<td></td>
</tr>
<tr>
<td>Step 2 ntp</td>
<td>Enters NTP configuration mode.</td>
</tr>
</tbody>
</table>
Purpose

**Command or Action**

<table>
<thead>
<tr>
<th>Step 3</th>
<th>master primary-reference-clock</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Example:</strong></td>
<td>RP/0/RSP0/CPU0:router(config-ntp)# master primary-reference-clock</td>
</tr>
</tbody>
</table>

**Purpose**

Specifies PTP to be the NTP time source.

**Step 4**

Use one of the following commands:

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

**Example:**

RP/0/RSP0/CPU0:router(config-ntp)# end

RP/0/RSP0/CPU0:router(config-ntp)# 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.

---

**Updating the Hardware Clock**

On devices that have hardware clocks (system calendars), you can configure the hardware clock to be periodically updated from the software clock. This is advisable for devices using NTP, because the time and date on the software clock (set using NTP) is more accurate than the hardware clock. The time setting on the hardware clock has the potential to drift slightly over time.

**Note**

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

1. configure
2. ntp
3. update-calendar
4. Use one of the following commands:
   • end
   • commit

DETAILED STEPS

<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>Configures the router to update its system calendar from the software clock at periodic intervals.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>RP/0/RSP0/CPU0:router(config)# ntp</td>
<td></td>
</tr>
<tr>
<td>Step 3 update-calendar</td>
<td>Enters NTP configuration mode.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>RP/0/RSP0/CPU0:router(config-ntp)# update-calendar</td>
<td></td>
</tr>
<tr>
<td>Step 4 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)# end or 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.

- Use the commit command to save the configuration changes to the running configuration file and remain within the configuration session.
Verifying the Status of the External Reference Clock

This task explains how to verify the status of NTP components.

Note: The commands can be entered in any order.

**SUMMARY STEPS**

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

**DETAILED STEPS**

<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><code>RP/0/RSP0/CPU0:router# show ntp associations</code></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><code>RP/0/RSP0/CPU0:router# show ntp status</code></td>
</tr>
</tbody>
</table>

**Examples**

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

```
RP/0/RSP0/CPU0:router# show ntp associations

+~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:

```
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
```
Configuration Examples for Implementing NTP

**Configuring Poll-Based Associations: Example**

The following example shows an NTP configuration in which the router’s system clock is configured to form a peer association with the time server host at IP address 192.168.22.33, and to allow the system clock to be synchronized by time server hosts at IP address 10.0.2.1 and 172.19.69.1:

```
ntp
  server 10.0.2.1 minpoll 5 maxpoll 7
  peer 192.168.22.33
  server 172.19.69.1
```

**Configuring Broadcast-Based Associations: Example**

The following example shows an NTP client configuration in which interface 0/2/0/0 is configured to receive NTP broadcast packets, and the estimated round-trip delay between an NTP client and an NTP broadcast server is set to 2 microseconds:

```
ntp
  interface tengige 0/2/0/0
    broadcast client
    exit
    broadcastdelay 2
```

The following example shows an NTP server configuration where interface 0/2/0/2 is configured to be a broadcast server:

```
ntp
  interface tengige 0/2/0/2
    broadcast
```

**Configuring NTP Access Groups: Example**

The following example shows a NTP access group configuration where the following access group restrictions are applied:

- Peer restrictions are applied to IP addresses that pass the criteria of the access list named peer-acl.
- Serve restrictions are applied to IP addresses that pass the criteria of access list named serve-acl.
- Serve-only restrictions are applied to IP addresses that pass the criteria of the access list named serve-only-acl.
- Query-only restrictions are applied to IP addresses that pass the criteria of the access list named query-only-acl.

```
ntp
  peer 10.1.1.1
  peer 10.1.1.1
  peer 10.2.2.2
```
peer 10.3.3.3
peer 10.4.4.4
peer 10.5.5.5
peer 10.6.6.6
peer 10.7.7.7
peer 10.8.8.8
access-group peer peer-acl
access-group serve serve-acl
access-group serve-only serve-only-acl
access-group query-only query-only-acl
exit
ipv4 access-list peer-acl
10 permit ip host 10.1.1.1 any
20 permit ip host 10.8.8.8 any
exit
ipv4 access-list serve-acl
10 permit ip host 10.4.4.4 any
20 permit ip host 10.5.5.5 any
exit
ipv4 access-list query-only-acl
10 permit ip host 10.2.2.2 any
20 permit ip host 10.3.3.3 any
exit
ipv4 access-list serve-only-acl
10 permit ip host 10.6.6.6 any
20 permit ip host 10.7.7.7 any
exit

**Configuring NTP Authentication: Example**

The following example shows an NTP authentication configuration. In this example, the following is configured:

- NTP authentication is enabled.
- Two authentication keys are configured (key 2 and key 3).
- The router is configured to allow its software clock to be synchronized with the clock of the peer (or vice versa) at IP address 10.3.32.154 using authentication key 2.
- The router is configured to allow its software clock to be synchronized with the clock by the device at IP address 10.32.154.145 using authentication key 3.
- The router is configured to synchronize only to systems providing authentication key 3 in their NTP packets.

```
nntp
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:

```
nntp
interface tengige 0/2/0/0
disable
exit
authentication-key 2 md5 encrypted 06120A2D40031D1008124
authentication-key 3 md5 encrypted 1311121E074110232621
authenticate
```
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
ttp
    authentication-key 2 md5 encrypted 06120A2D40031D1008124
    authentication-key 3 md5 encrypted 1311121E074110232621
    authenticate
    trusted-key 3
    server 10.3.32.154 key 3
tpeer 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
ttp
    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
ttp
    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> configure</td>
<td>Enters NTP configuration mode.</td>
</tr>
<tr>
<td><strong>Step 2</strong> ntp</td>
<td>Specify name of a VRF (VPN- routing and forwarding) instance to configure.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>RP/0/RSP0/CPU0:router(config)# ntp vrf Customer_A</td>
</tr>
<tr>
<td><strong>Step 3</strong> vrf vrf-name</td>
<td>Configures an interface from which the IP source address is taken. This allows IOS-XR to respond to NTP queries on VRF interfaces, in this case the source is BVI.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>RP/0/RSP0/CPU0:router(config)# ntp vrf Customer_A source bvi 70</td>
</tr>
<tr>
<td><strong>Step 4</strong> source interface-type interface-instance</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 <code>source</code> keyword in the <code>peer</code> or <code>server</code> command shown in Configuring Poll-Based Associations, on page 209.</td>
</tr>
<tr>
<td><strong>Note</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Step 5</strong> Use one of the following commands:</td>
<td>Saves configuration changes.</td>
</tr>
<tr>
<td>• <code>end</code></td>
<td>• When you issue the <code>end</code> command, the system prompts you to commit changes:</td>
</tr>
<tr>
<td>• <code>commit</code></td>
<td>Uncommitted changes found, commit them before exiting(yes/no/cancel)?</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>[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>
</tbody>
</table>
Purpose
Command or Action | Purpose
---|---
or | - Entering `no` exits the configuration session and returns the router to EXEC mode without committing the configuration changes.
RP/0/RSP0/CPU0:router(config-ntp)# commit | - 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>
</tr>
</thead>
<tbody>
<tr>
<td>Cisco IOS XR clock commands</td>
<td>Clock Commands on the Cisco ASR 9000 Series Router module of Cisco ASR 9000 Series Aggregation Services Router System Management Command Reference</td>
</tr>
<tr>
<td>Cisco IOS XR NTP commands</td>
<td>NTP Commands on module of Cisco ASR 9000 Series Aggregation Services Router System Management Command Reference</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 Cisco ASR 9000 Series Aggregation Services Router System Security Configuration 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 Link</th>
<th>MIBs</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

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: [http://cisco.com/public/sw-center/netmgmt/cmtk/mibs.shtml](http://cisco.com/public/sw-center/netmgmt/cmtk/mibs.shtml)

### 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 12

Configuring PTP

*Precision Time Protocol* (PTP) is a protocol that defines a method to distribute time around a network. PTP support is based on the IEEE 1588-2008 standard.

This module describes the tasks you need to configure PTP on the Cisco IOS XR software.

For more information about PTP on the Cisco IOS XR software and complete descriptions of the PTP commands listed in this module, see *Additional References*, on page 259. 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 26: Feature History for Implementing PTP on Cisco IOS XR Software**

<table>
<thead>
<tr>
<th>Release</th>
<th>Modification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Release 4.2.0</td>
<td>This feature was introduced.</td>
</tr>
<tr>
<td>Release 4.3.0</td>
<td>Support for hybrid mode and Telecom Profile were added.</td>
</tr>
<tr>
<td>Release 4.3.1</td>
<td>Support for PTP in Ethernet link bundles was added.</td>
</tr>
</tbody>
</table>

This module contains the following topics:

- Prerequisites for Implementing PTP on Cisco IOS XR Software, page 234
- Information About Configuring PTP, page 234
- States of Ports, page 237
- How to Configure PTP, page 238
- How to Configure PTP Telecom Profile, page 252
- Configuration Examples for Implementing PTP, page 257
- Additional References, page 259
Prerequisites for Implementing PTP 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 Configuring PTP

PTP Implementation

IEEE Standard 1588-2008 defines a method for distributing time around a network using the Precision Time Protocol (PTP) version 2. 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.

PTP consists of two parts:

- The port state machine and best master clock algorithm, which provides a method to determine which ports in the network will run as master (providing time to other clocks to the network), which will run as slaves (receiving time from other clocks in the network), and which will be passive (neither master nor slave).

- Mechanisms for slave ports to calculate the difference between the time of their own clocks and the time of their master clock. To calculate the differences, PTP uses a delay request/response mechanism and a peer delay mechanism.

Note

Peer-delay mechanism is not supported on the Cisco ASR 9000 Series routers.

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 (G, 10G, 40G, and 100G), Bundle Ethernet interfaces, and sub-interfaces. PTP is not configurable on LAG Ethernet sub-interfaces.

PTP Transport Media

PTP is supported over the following transport media:

- UDP over IPv4

PTP Messages

PTP supports the following message types:

- Signaling
- Announce
- Sync
Follow-up
Delay-request
Delay-Response
Management

Unicast and Multicast Messages

PTP supports the following options for unicast and multicast:

- Unicast mode: In this mode, all PTP messages are sent as unicast messages. This is the default behavior.
- Mixed mode: (Not supported for ASR 9000 series routers) In this mode, Announce and Sync messages are sent as multicast messages, while Signaling, Delay-Request, and Delay-Response messages are sent as unicast messages.
- Multicast mode: In this mode, all packets are sent as multicast messages.

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, is a mechanism which allows a slave port to estimate to a good degree of accuracy 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 the Sync message is sent in the Sync message itself.
- Two-step mechanism - The timestamp for the Sync message in a later 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.

PTP Interface and Profile Configuration

If a global PTP profile is attached to an interface, its values are used as the default settings for that interface. If additional settings are configured under the interface itself, these override the defaults in the profile. If no profile is attached to an interface, the configuration on the interface is used to determine the PTP settings for the interface.

You can use either of the following approaches when configuring PTP:

- 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.
1588 Packet Types

- **Announce**: Used to announce the existence of PTP clocks throughout the network. Sent by ports in MASTER state.
- **Sync/Follow-Up/Delay-Req/Delay-Resp**: Used to exchange timestamps between master and slave, to synchronize time.
- **Signalling Messages**: Used to negotiate unicast grants.

PTP 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.

Related Topics
- Configuring PTP Hybrid Mode, on page 250
- PTP Hybrid Mode: Example, on page 258
- Configuring Frequency Synchronization, on page 191

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 this profile network are Ordinary Clocks.

G.8265.1 profile defines an alternate algorithm to select between different master clocks based on the local priority given to each master clock and their quality levels (QL). This profile also defines Packet Timing Signal Fail (PTSF) conditions to identify the master clocks that do not qualify for selection. They are:

• PTSF-lossSync condition: Raised for master clocks that do not receive a reliable stream of Sync and Delay-Resp messages. Cisco IOS XR software requests Sync and Delay-Resp grants for each configured master clock to track the master clock with this condition.

• PTSF-lossAnnounce condition: Raised for master clocks that do not receive a reliable stream of Announce messages.

• PTSF-unusable condition: Raised for master clocks that receives a reliable stream of Announce, Sync, and Delay-Resp messages, but not usable by slave clocks. Cisco IOS XR software does not use this condition.

**States of Ports**

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

• **INIT** – Port is not yet ready to participate in PTP.

• **LISTENING** – First state when a port becomes ready to participate in PTP; port listens for PTP masters for a (configurable) period of time.

• **PRE-MASTER** – The port is about to go into MASTER state.

• **MASTER** – The port is provides timestamps for any listening slave/boundary clocks.
• UNCALIBRATED – The port receives timestamps from a master clock, but the router’s clock is not yet synchronized to that master.
• SLAVE – The port receives timestamps from a master clock, and the router’s clock is synchronized to that master.
• PASSIVE – The port is aware of a better clock than the one it would advertise if it was in MASTER state, but is not slaving off that clock.

How to Configure PTP

Configuring Frequency and Quality Settings for PTP

These steps configure frequency and quality settings for PTP:

**SUMMARY STEPS**

1. configure
2. frequency synchronization
3. quality itu-t option option generation number
4. 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>Enters frequency synchronization mode.</td>
</tr>
<tr>
<td>Step 2 frequency synchronization</td>
<td></td>
</tr>
<tr>
<td>Example: RP/0/RSP0/CPU0:router(config)# frequency synchronization</td>
<td></td>
</tr>
<tr>
<td>Step 3 quality itu-t option option generation number</td>
<td>Sets ITU-T quality parameters.</td>
</tr>
<tr>
<td>Example: RP/0/RSP0/CPU0:router(config-freqsync)# quality itu-t option 2 generation 2</td>
<td></td>
</tr>
<tr>
<td>Step 4 Use one of these commands:</td>
<td>Saves configuration changes.</td>
</tr>
</tbody>
</table>
### Configuring Global Profile Settings for PTP

Use these steps to configure a global configuration profile for a PTP interface. This profile can then be assigned to any interface as required. You can override this configuration for any particular interface using configuration commands in interface PTP configuration mode. See Configuring a PTP Slave Interface, on page 241 or Configuring a PTP Master Interface, on page 245 for more information.

#### SUMMARY STEPS

1. configure
2. ptp
3. profile name
4. sync frequency rate
5. delay-request frequency rate
6. Use one of these commands:
   - end
   - commit

---

### Command or Action | Purpose
---|---
- end | 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.

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

---

Example:

RP/0/RSP0/CPU0:router(config-freqsync)#
end

or

RP/0/RSP0/CPU0:router(config-freqsync)#
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><strong>Purpose</strong></td>
</tr>
<tr>
<td><strong>Step 2</strong> ptp</td>
<td>Enters PTP configuration mode.</td>
</tr>
<tr>
<td><strong>Example:</strong> RP/0/RSP0/CPU0:router(config)# ptp</td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong> profile name</td>
<td>Enters PTP profile configuration mode for the specified profile.</td>
</tr>
<tr>
<td><strong>Example:</strong> RP/0/RSP0/CPU0:router(config-ptp)# profile tp64</td>
<td></td>
</tr>
<tr>
<td><strong>Step 4</strong> sync frequency rate</td>
<td>Configures the Sync message frequency for the profile.</td>
</tr>
<tr>
<td><strong>Example:</strong> RP/0/RSP0/CPU0:router(config-ptp-profile)# sync frequency 64</td>
<td></td>
</tr>
<tr>
<td><strong>Step 5</strong> delay-request frequency rate</td>
<td>Sets the delay request frequency for the profile.</td>
</tr>
<tr>
<td><strong>Example:</strong> RP/0/RSP0/CPU0:router(config-ptp-profile)# delay-request frequency 64</td>
<td></td>
</tr>
<tr>
<td><strong>Step 6</strong> Use one of these commands:</td>
<td>Saves configuration changes.</td>
</tr>
<tr>
<td>• end</td>
<td>• When you issue the <em>end</em> command, the system prompts you to commit changes:</td>
</tr>
<tr>
<td>• commit</td>
<td><strong>Uncommitted changes found, commit them before exiting(yes/no/cancel)? [cancel]:</strong></td>
</tr>
<tr>
<td><strong>Example:</strong> RP/0/RSP0/CPU0:router(config-ptp-profile)# end</td>
<td></td>
</tr>
<tr>
<td>or</td>
<td>• Entering <em>yes</em> 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 <em>commit</em> command to save the configuration changes to the running configuration file, and remain within the configuration session.</td>
</tr>
</tbody>
</table>
Configuring a PTP Slave Interface

Use these steps to configure an interface to be a PTP slave:

**SUMMARY STEPS**

1. configure
2. interface type interface-path-id
3. ptp
4. profile name
5. transport ipv4
6. announce timeout timeout
7. port state slave-only
8. master {ipv4 address | ipv6 address}
9. exit
10. ipv4 address address mask
11. transceiver permit pid all
12. commit
13. show run interface value

**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>interface type interface-path-id</td>
</tr>
<tr>
<td>Example:</td>
<td>RP/0/RSP0/CPU0:router(config)# interface TenGigE 0/1/0/5</td>
</tr>
<tr>
<td><strong>Step 3</strong></td>
<td>ptp</td>
</tr>
<tr>
<td>Example:</td>
<td>RP/0/RSP0/CPU0:router(config-if)# ptp</td>
</tr>
</tbody>
</table>
### Configuring PTP Slave Interface

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 4</strong> profile name</td>
<td>Specifies a previously-defined configuration profile to use for this interface. See Configuring Global Profile Settings for PTP, on page 239 for more information. Any additional commands entered in PTP interface configuration mode override settings in this profile.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>RP/0/RSP0/CPU0:router(config-if-ptp)# profile tp64</td>
<td></td>
</tr>
<tr>
<td><strong>Step 5</strong> transport ipv4</td>
<td>Specifies that IPv4 is the transport mode for PTP messages.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>RP/0/RSP0/CPU0:router(config-if-ptp)# transport ipv4</td>
<td></td>
</tr>
<tr>
<td><strong>Step 6</strong> announce timeout timeout</td>
<td>Sets the timeout for PTP announce messages.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>RP/0/RSP0/CPU0:router(config-if-ptp)# announce timeout 2</td>
<td></td>
</tr>
<tr>
<td><strong>Step 7</strong> port state slave-only</td>
<td>Specifies that the port state is for a slave.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>RP/0/RSP0/CPU0:router(config-if-ptp)# port state slave-only</td>
<td></td>
</tr>
<tr>
<td><strong>Step 8</strong> master {ipv4 address</td>
<td>ipv6 address}</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>RP/0/RSP0/CPU0:router(config-if-ptp)# master ipv4 192.168.2.1</td>
<td></td>
</tr>
<tr>
<td>RP/0/RSP0/CPU0:router(config-if-ptp)# master ipv6 2001:DB8::1</td>
<td></td>
</tr>
<tr>
<td><strong>Step 9</strong> exit</td>
<td>Exits PTP interface configuration mode.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>RP/0/RSP0/CPU0:router(config-if-ptp)# exit</td>
<td></td>
</tr>
<tr>
<td><strong>Step 10</strong> ipv4 address address mask</td>
<td>Configures the gateway for the interface.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>RP/0/RSP0/CPU0:router(config-if)# ipv4 address 1.1.1.255.255.255.0</td>
<td></td>
</tr>
<tr>
<td><strong>Step 11</strong> transceiver permit pid all</td>
<td>Configures the transceiver for the interface.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>RP/0/RSP0/CPU0:router(config-if)# transceiver permit pid all</td>
<td></td>
</tr>
<tr>
<td><strong>Step 12</strong> commit</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Command or Action</td>
<td>Purpose</td>
</tr>
<tr>
<td>-------------------</td>
<td>---------</td>
</tr>
<tr>
<td><strong>Step 13</strong> show run interface value</td>
<td>Displays the running configuration.</td>
</tr>
</tbody>
</table>

**Example:**
```
RP/0/RSP0/CPU0:router# show run interface tengige0/1/0/5
Fri Aug 3 19:57:14.184 UTC
interface TenGigE0/1/0/5
  ptp
    profile tp64
    transport ipv4
    port state slave-only
    master ipv4 1.7.1.2
    announce timeout 2
    ipv4 address 1.7.1.1 255.255.255.0
    transceiver permit pid all
```

---

**Configuring the Clock Interface for a PTP Master**

Use these steps to configure a clock interface for the PTP master:

**SUMMARY STEPS**

1. configure
2. clock-interface sync value location node
3. port-parameters dti
4. frequency synchronization
5. selection input
6. priority number
7. wait-to-restore number
8. ssm disable
9. quality receive exact itu-t option number generation number PRS
10. 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> configure</td>
<td>Enters configuration mode for the specified clock interface.</td>
</tr>
<tr>
<td><strong>Step 2</strong> clock-interface sync value location node</td>
<td>Configures the port parameters for the clock interface.</td>
</tr>
<tr>
<td>Example: RP/0/RSP0/CPU0:router(config)# clock-interface sync 1 location 0/RSP0/CPU0</td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong> port-parameters dti</td>
<td>Enters frequency synchronization mode for the clock interface.</td>
</tr>
<tr>
<td>Example: RP/0/RSP0/CPU0:router(config-clock-if)# port-parameters dti</td>
<td></td>
</tr>
<tr>
<td><strong>Step 4</strong> frequency synchronization</td>
<td>Configures selection input for the clock interface.</td>
</tr>
<tr>
<td>Example: RP/0/RSP0/CPU0:router(config-clock-if)# frequency synchronization</td>
<td></td>
</tr>
<tr>
<td><strong>Step 5</strong> selection input</td>
<td>Configures priority for the clock interface.</td>
</tr>
<tr>
<td>Example: RP/0/RSP0/CPU0:router(config-clk-freqsync)# selection input</td>
<td></td>
</tr>
<tr>
<td><strong>Step 6</strong> priority number</td>
<td>Configures the wait-to-restore time for the clock interface.</td>
</tr>
<tr>
<td>Example: RP/0/RSP0/CPU0:router(config-clk-freqsync)# priority 10</td>
<td></td>
</tr>
<tr>
<td><strong>Step 7</strong> wait-to-restore number</td>
<td>Disables SSM packets for the clock interface.</td>
</tr>
<tr>
<td>Example: RP/0/RSP0/CPU0:router(config-clk-freqsync)# wait-to-restore 0</td>
<td></td>
</tr>
<tr>
<td><strong>Step 8</strong> ssm disable</td>
<td></td>
</tr>
<tr>
<td>Example: RP/0/RSP0/CPU0:router(config-clk-freqsync)# ssm disable</td>
<td></td>
</tr>
</tbody>
</table>
### Configuring PTP

#### Configuring a PTP Master Interface

Use these steps to configure an interface that acts as a PTP master.

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 9</strong></td>
<td><strong>quality receive exact itu-t option number generation number PRS</strong></td>
</tr>
<tr>
<td>Example:</td>
<td>RP/0/RSP0/CPU0:router(config-clk-freqsync)# quality receive exact itu-t option 2 generation 2 PRS</td>
</tr>
<tr>
<td><strong>Step 10</strong></td>
<td>Use one of these commands:</td>
</tr>
<tr>
<td></td>
<td>• end</td>
</tr>
<tr>
<td></td>
<td>• commit</td>
</tr>
<tr>
<td>Example:</td>
<td>RP/0/RSP0/CPU0:router(config-clk-freqsync)# end or RP/0/RSP0/CPU0:router(config-clk-freqsync)# commit</td>
</tr>
<tr>
<td><strong>Step 9</strong></td>
<td>Configures quality settings for frequency synchronization for the clock interface.</td>
</tr>
<tr>
<td><strong>Step 10</strong></td>
<td>Saves configuration changes.</td>
</tr>
<tr>
<td></td>
<td>• When you issue the <strong>end</strong> 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 <strong>commit</strong> command to save the configuration changes to the running configuration file, and remain within the configuration session.</td>
</tr>
</tbody>
</table>
SUMMARY STEPS

1. configure
2. interface type interface-path-id
3. ptp
4. profile name
5. transport ipv4
6. announce timeout timeout
7. exit
8. ipv4 address address mask
9. transceiver permit pid all
10. commit
11. show run interface value

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 configuration mode for a specified interface. PTP is supported on Gigabit Ethernet and Bundle Ethernet interfaces.</td>
</tr>
<tr>
<td><strong>Step 2</strong> interface type interface-path-id</td>
<td>Enters PTP configuration mode for the interface. A single member of the bundle is selected on which to send all PTP packets. In the event that this member goes down, another member is selected on which to send all PTP packets.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>RP/0/RSP0/CPU0:router(config)# interface TenGigE 0/1/0/5</td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong> ptp</td>
<td>Enters PTP configuration mode for the interface.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>RP/0/RSP0/CPU0:router(config-if)# ptp</td>
<td></td>
</tr>
<tr>
<td><strong>Step 4</strong> profile name</td>
<td>Specifies a previously-defined configuration profile to use for this interface. See Configuring Global Profile Settings for PTP, on page 239 for more information. Any additional commands entered in PTP interface configuration mode override settings in this profile.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>RP/0/RSP0/CPU0:router(config-if-ptp)# profile tp64</td>
<td></td>
</tr>
<tr>
<td><strong>Step 5</strong> transport ipv4</td>
<td>Specifies that IPv4 is the transport mode for PTP messages.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>RP/0/RSP0/CPU0:router(config-if-ptp)# transport ipv4</td>
<td></td>
</tr>
<tr>
<td>Command or Action</td>
<td>Purpose</td>
</tr>
<tr>
<td>-------------------</td>
<td>---------</td>
</tr>
</tbody>
</table>
| **Step 6**  
announce timeout timeout | Sets the timeout for PTP announce messages. |
| **Example:**  
RP/0/RSP0/CPU0:router(config-if-ptp)# announce timeout 2 | |
| **Step 7**  
exit | Returns to configuration mode for the interface. |
| **Example:**  
RP/0/RSP0/CPU0:router(config-if-ptp)# exit | |
| **Step 8**  
ipv4 address address mask | Configures the gateway for the interface. |
| **Example:**  
RP/0/RSP0/CPU0:router(config-if)# ipv4 address 1.7.1.2 255.255.255.0 | |
| **Step 9**  
transceiver permit pid all | Configures the transceiver for the interface. |
| **Example:**  
RP/0/RSP0/CPU0:router(config-if)# transceiver permit pid all | |
| **Step 10**  
commit | |
| **Step 11**  
show run interface value | Shows the running configuration. |
| **Example:**  
RP/0/RSP0/CPU0:router# show run interface  
Te0/1/0/5  
Fri Aug 3 13:57:44.366 PST  
interface TenGigE0/5/1/0  
ptp  
profile tp64  
transport ipv4  
announce timeout 2  
!  
ipv4 address 1.7.1.2 255.255.255.0  
transceiver permit pid all  
| |

### Configuring GPS Settings for the Grand Master Clock

Use these steps to configure GPS settings for PTP.
### SUMMARY STEPS

1. configure
2. clock-interface sync port-number location interface-location
3. port-parameters
4. gps-input tod-format cisco pps-input rs422
5. exit
6. frequency synchronization
7. selection input
8. priority number
9. wait-to-restore number
10. ssm disable
11. quality receive exact itu-t option option generation number
12. Use one of these commands:
   - end
   - commit
13. show run interface value

### 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>clock-interface sync port-number location interface-location</td>
</tr>
<tr>
<td>Example:</td>
<td>RP/0/RSP0/CPU0:router(config)# clock-interface sync 2 location 0/RSP0/CPU0</td>
</tr>
<tr>
<td><strong>Step 3</strong></td>
<td>port-parameters</td>
</tr>
<tr>
<td>Example:</td>
<td>RP/0/RSP0/CPU0:router(config-clock-if)# port-parameters</td>
</tr>
<tr>
<td><strong>Step 4</strong></td>
<td>gps-input tod-format cisco pps-input rs422</td>
</tr>
<tr>
<td>Example:</td>
<td>RP/0/RSP0/CPU0:router(config-clk-parms)# gps-input tod-format cisco pps-input rs422</td>
</tr>
<tr>
<td>Step</td>
<td>Command or Action</td>
</tr>
<tr>
<td>--------</td>
<td>--------------------------------------------</td>
</tr>
<tr>
<td>Step 5</td>
<td>exit</td>
</tr>
</tbody>
</table>

Example:

```
RP/0/RSP0/CPU0:router(config-clk-parms)# exit
```

Step 6 | frequency synchronization                  | Enters frequency synchronization mode for the clock interface. |

Example:

```
RP/0/RSP0/CPU0:router(config-clock-if)# frequency synchronization
```

Step 7 | selection input                            | Configures selection input for the clock interface. |

Example:

```
RP/0/RSP0/CPU0:router(config-clk-freqsync)# selection input
```

Step 8 | priority `number`                          | Configures priority for the clock interface.     |

Example:

```
RP/0/RSP0/CPU0:router(config-clk-freqsync)# priority 10
```

Step 9 | wait-to-restore `number`                   | Configures the wait-to-restore time for the clock interface. |

Example:

```
RP/0/RSP0/CPU0:router(config-clk-freqsync)# wait-to-restore 0
```

Step 10 | ssm disable                                | Disables SSM packets for the clock interface.   |

Example:

```
RP/0/RSP0/CPU0:router(config-clk-freqsync)# ssm disable
```

Step 11 | quality receive exact itu-t option option generation `number` | Configures ITU-T quality parameters. |

Example:

```
RP/0/RSP0/CPU0:router(config-clk-freqsync)# quality receive exact itu-t option 2 generation 2 PRS
```

Step 12 | Use one of these commands:                 | Saves configuration changes.                     |

- end
- commit

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

```
Uncommitted changes found, commit them
```
### Purpose

- Command or Action
- 
  **Example:**
  - RP/0/RSP0/CPU0:router(config-clk-freqsync)# end
  - RP/0/RSP0/CPU0:router(config-clk-freqsync)# commit

- Purpose
  - 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.

#### Step 13

- Command or Action: `show run interface` *value*
- 
  **Example:**
  - RP/0/RSP0/CPU0:router# show run interface Te0/1/0/5
  - Fri Aug  3 13:57:44.366 PST
  - interface TenGigE0/5/1/0
    - ptp
      - profile tp64
      - transport ipv4
      - announce timeout 2
      - ipv4 address 1.7.1.2 255.255.255.0
      - transceiver permit pid all

- Purpose
  - Shows the running configuration.

---

**Configuring PTP Hybrid Mode**

You configure hybrid mode by selecting PTP for the time-of-day (ToD) and another source for the frequency. This task summaries the hybrid configuration. Refer to the other PTP configuration modules for more detailed information regarding the PTP configurations. Refer to the Configuring Ethernet Interfaces module in Cisco ASR 9000 Series Aggregation Services Router Interface and Hardware Component Configuration Guide for more information regarding SyncE configurations.
### SUMMARY STEPS

1. Enable Frequency Synchronization.
2. Configure a SyncE input.
3. Enable PTP on the router.
4. Configure a PTP interface on the router.

### 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>Enable Frequency Synchronization.</td>
<td>Enables frequency synchronization on the router.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><code>RP/0/RSP0/CPU0:router(config)# frequency synchronization</code></td>
<td></td>
</tr>
<tr>
<td></td>
<td><code>RP/0/RSP0/CPU0:router(config)# commit</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 2</strong></td>
<td>Configure a SyncE input.</td>
<td>Configures an interface to be a SyncE input. It is also possible to configure BITS or SONET/SDH as the frequency source. The time-of-day-priority setting specifies that SyncE is used as the ToD source if no source has a lower priority.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><code>RP/0/RSP0/CPU0:router(config)# interface GigabitEthernet 0/1/0/0</code></td>
<td></td>
</tr>
<tr>
<td></td>
<td><code>RP/0/RSP0/CPU0:router(config-if)# frequency synchronization</code></td>
<td></td>
</tr>
<tr>
<td></td>
<td><code>RP/0/RSP0/CPU0:router(config-if-freqsync)# selection input</code></td>
<td></td>
</tr>
<tr>
<td></td>
<td><code>RP/0/RSP0/CPU0:router(config-if-freqsync)# time-of-day-priority 100</code></td>
<td></td>
</tr>
<tr>
<td></td>
<td><code>RP/0/RSP0/CPU0:router(config-if-freqsync)# commit</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong></td>
<td>Enable PTP on the router.</td>
<td>Enables PTP on the router and specifies that PTP is the ToD source if it is available. Values for the ToD priority can range from 1 (highest priority) to 254 (lowest priority).</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><code>RP/0/RSP0/CPU0:router(config)# ptp</code></td>
<td></td>
</tr>
<tr>
<td></td>
<td><code>RP/0/RSP0/CPU0:router(config-tp)# time-of-day priority 1</code></td>
<td></td>
</tr>
<tr>
<td></td>
<td><code>RP/0/RSP0/CPU0:router(config)# commit</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 4</strong></td>
<td>Configure a PTP interface on the router.</td>
<td>Enables a PTP interface on the router and specifies an interface as the PTP master.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><code>RP/0/RSP0/CPU0:router(config)# interface GigabitEthernet 0/1/0/1</code></td>
<td></td>
</tr>
<tr>
<td></td>
<td><code>RP/0/RSP0/CPU0:router(config-if)# ipv4 address 10.0.0.1/24</code></td>
<td></td>
</tr>
<tr>
<td></td>
<td><code>RP/0/RSP0/CPU0:router(config-if)# ptp</code></td>
<td></td>
</tr>
<tr>
<td></td>
<td><code>RP/0/RSP0/CPU0:router(config-if-tp)# master ipv4 10.0.0.2</code></td>
<td></td>
</tr>
<tr>
<td></td>
<td><code>RP/0/RSP0/CPU0:router(config-if-tp)# commit</code></td>
<td></td>
</tr>
</tbody>
</table>
How to Configure PTP Telecom Profile

Configuring an Interface for the PTP Telecom Profile

This task details the interface settings that are applicable to 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.

SUMMARY STEPS

1. configure
2. interface type interface-path-id
3. ptp
4. profile name
5. sync frequency rate
6. delay-request frequency rate
7. announce grant-duration duration
8. sync grant-duration duration
9. delay-response grant-duration duration
10. sync timeout timeout
11. delay-response timeout timeout
12. unicast-grant invalid-request {reduce | deny}
13. master {ipv4 ip-address|ipv6 ip-address}
14. clock-class class
15. 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> configure</td>
<td>Enters interface configuration mode for the specified interface.</td>
</tr>
<tr>
<td><strong>Step 2</strong> interface type interface-path-id</td>
<td></td>
</tr>
<tr>
<td>Example: RP/0/RSP0/CPU0:router(config)# interface gigabitethernet 0/1/0/1</td>
<td></td>
</tr>
<tr>
<td>Step</td>
<td>Command or Action</td>
</tr>
<tr>
<td>------</td>
<td>------------------</td>
</tr>
<tr>
<td>3</td>
<td>ptp</td>
</tr>
<tr>
<td></td>
<td><strong>Example:</strong></td>
</tr>
<tr>
<td></td>
<td>RP/0/RSP0/CPU0:router(config-if)# ptp</td>
</tr>
<tr>
<td>4</td>
<td>profile name</td>
</tr>
<tr>
<td></td>
<td><strong>Note:</strong> Any configurations made in PTP interface configuration mode override the global profile settings.</td>
</tr>
<tr>
<td></td>
<td><strong>Example:</strong></td>
</tr>
<tr>
<td></td>
<td>RP/0/RSP0/CPU0:router(config-if-ptp)# profile tele64</td>
</tr>
<tr>
<td>5</td>
<td>sync frequency rate</td>
</tr>
<tr>
<td></td>
<td><strong>Example:</strong></td>
</tr>
<tr>
<td></td>
<td>RP/0/RSP0/CPU0:router(config-if-ptp)# sync frequency 128</td>
</tr>
<tr>
<td>6</td>
<td>delay-request frequency rate</td>
</tr>
<tr>
<td></td>
<td><strong>Example:</strong></td>
</tr>
<tr>
<td></td>
<td>RP/0/RSP0/CPU0:router(config-if-ptp)# delay-request frequency 128</td>
</tr>
<tr>
<td>7</td>
<td>announce grant-duration duration</td>
</tr>
<tr>
<td></td>
<td><strong>Example:</strong></td>
</tr>
<tr>
<td></td>
<td>RP/0/RSP0/CPU0:router(config-if-ptp)# announce grant-duration 120</td>
</tr>
<tr>
<td>8</td>
<td>sync grant-duration duration</td>
</tr>
<tr>
<td></td>
<td><strong>Example:</strong></td>
</tr>
<tr>
<td></td>
<td>RP/0/RSP0/CPU0:router(config-if-ptp)# sync grant-duration 120</td>
</tr>
<tr>
<td>9</td>
<td>delay-response grant-duration duration</td>
</tr>
<tr>
<td></td>
<td><strong>Example:</strong></td>
</tr>
<tr>
<td></td>
<td>RP/0/RSP0/CPU0:router(config-if-ptp)# delay-response grant-duration 120</td>
</tr>
<tr>
<td>10</td>
<td>sync timeout timeout</td>
</tr>
<tr>
<td></td>
<td><strong>Example:</strong></td>
</tr>
<tr>
<td></td>
<td>RP/0/RSP0/CPU0:router(config-if-ptp)# sync timeout 120</td>
</tr>
<tr>
<td>Command or Action</td>
<td>Purpose</td>
</tr>
<tr>
<td>------------------</td>
<td>---------</td>
</tr>
<tr>
<td><strong>Step 11</strong></td>
<td>delay-response timeout <code>timeout</code>&lt;br&gt;<strong>Example:</strong>&lt;br&gt;RP/0/RSP0/CPU0:router(config-if-ptp)# delay-response timeout 120</td>
</tr>
<tr>
<td><strong>Step 12</strong></td>
<td>unicast-grant invalid-request `{reduce</td>
</tr>
<tr>
<td><strong>Step 13</strong></td>
<td>master `{ipv4 ipv-address</td>
</tr>
<tr>
<td><strong>Step 14</strong></td>
<td>clock-class <code>class</code>&lt;br&gt;<strong>Example:</strong>&lt;br&gt;RP/0/RSP0/CPU0:router(config-if-ptp-master)# clock-class 2</td>
</tr>
</tbody>
</table>
| **Step 15** | Use one of these commands:<br>• end<br>• commit<br>**Example:**<br>RP/0/RSP0/CPU0:router(config-if-ptp-master)# end<br>or<br>RP/0/RSP0/CPU0:router(config-if-ptp-master)# commit | Saves configuration changes.<br>- When you issue the **end** command, the system prompts you to commit changes:<br>```
Uncommitted changes found, commit them before exiting(yes/no/cancel)? [cancel]:
```<br>• Entering yes saves configuration changes to the running configuration file, exits the configuration session, and returns the router to EXEC mode.<br>• Entering no exits the configuration session and returns the router to EXEC mode without committing the configuration changes.<br>• Entering cancel leaves the router in the current configuration session without exiting or committing the configuration changes.<br>- Use the **commit** command to save the configuration changes to the running configuration file, and remain within the configuration session. |
Configuring PTP Clock Settings for the Telecom Profile

Perform this task to configure clock settings to be consistent with ITU-T Telecom Profiles for Frequency.

**SUMMARY STEPS**

1. **configure**
2. **ptp**
3. **clock**
4. **domain**
5. **timescale**
6. **time-source source**
7. **exit**
8. **clock-selection telecom-profile**
9. **clock-advertisement telecom-profile**
10. 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></td>
</tr>
<tr>
<td><strong>configure</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Step 2</strong></td>
<td></td>
</tr>
<tr>
<td><strong>ptp</strong></td>
<td>Enters PTP configuration mode.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>RP/0/RSP0/CPU0:router(config)# ptp</td>
<td></td>
</tr>
<tr>
<td>RP/0/RSP0/CPU0:router(config-ptp)#</td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong></td>
<td></td>
</tr>
<tr>
<td><strong>clock</strong></td>
<td>Enters PTP clock configuration mode.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>RP/0/RSP0/CPU0:router(config-ptp)# clock</td>
<td></td>
</tr>
<tr>
<td>RP/0/RSP0/CPU0:router(config-ptp-clock)#</td>
<td></td>
</tr>
</tbody>
</table>
### Configuring PTP Clock Settings for the Telecom Profile

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 4</strong> domain</td>
<td>Sets the domain number for the PTP profile. 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.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>RP/0/RSP0/CPU0:router(config-ptp)# domain 4</td>
</tr>
<tr>
<td><strong>Step 5</strong> timescale</td>
<td>Sets the timescale to PTP.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>RP/0/RSP0/CPU0:router(config-ptp-clock)# timescale ptp</td>
</tr>
<tr>
<td><strong>Step 6</strong> time-source source</td>
<td>Sets the time source advertised in Announce messages. Valid options are: atomic-clock, GPS, hand-set, internal-oscillator, NTP, other, PTP, terrestrial-radio.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>RP/0/RSP0/CPU0:router(config-ptp-clock)# time-source ptp</td>
</tr>
<tr>
<td><strong>Step 7</strong> exit</td>
<td>Exits PTP clock configuration mode.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>RP/0/RSP0/CPU0:router(config-ptp-clock)# exit</td>
</tr>
<tr>
<td><strong>Step 8</strong> clock-selection telecom-profile</td>
<td>Specifies that the clock selection behavior, i.e. the best master clock algorithm in use, follows the telecom profile for frequency (ITU-T G.8265.1).</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>RP/0/RSP0/CPU0:router(config-ptp)# clock-selection telecom-profile</td>
</tr>
<tr>
<td><strong>Step 9</strong> clock-advertisement telecom-profile</td>
<td>Specifies that the parameters used in Announce messages follows the Telecom profile for frequency (ITU-T G.8265.1).</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>RP/0/RSP0/CPU0:router(config-ptp)# clock-advertisement telecom-profile</td>
</tr>
<tr>
<td><strong>Step 10</strong></td>
<td>Saves configuration changes.</td>
</tr>
<tr>
<td>Use one of these commands:</td>
<td></td>
</tr>
<tr>
<td>- end</td>
<td>• When you issue the <strong>end</strong> 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>RP/0/RSP0/CPU0:router(config-ptp)# end or RP/0/RSP0/CPU0:router(config-ptp)# commit</td>
</tr>
</tbody>
</table>

• Entering yes saves configuration changes to the running configuration file, exits the configuration session, and returns the router to EXEC mode.

• Entering no exits the configuration session and returns the router to EXEC mode without committing the configuration changes.

• Entering cancel leaves the router in the current configuration session without exiting or committing the configuration changes.
**Command or Action** | **Purpose**
--- | ---
 | • Use the **commit** command to save the configuration changes to the running configuration file, and remain within the configuration session.

**What to Do Next**
Configure your interface to be consistent with the ITU-T Telecom Profile.

# Configuration Examples for Implementing PTP

## Configuring Slave Settings: Example

The following example shows a PTP slave configuration.

```plaintext
ptp
 profile tp64
 transport ipv4
 port state slave-only
 master ipv4 1.7.1.2
 !
 announce timeout 2
 !
 ipv4 address 1.7.1.1 255.255.255.0
 transceiver permit pid all
 !
```

## Configuring Master Settings: Example

This example shows a PTP master configuration.

```plaintext
ptp
 profile tp64
 transport ipv4
 announce timeout 2
 !
 ipv4 address 1.7.1.2 255.255.255.0
 transceiver permit pid all
 !
```

## Configuring GPS Settings: Example

This example shows the GPS configuration for PTP.

```plaintext
clock-interface sync 2 location 0/RSP0/CPU0
 port-parameters
```
PTP Hybrid Mode: Example

This example shows the configuration of PTP hybrid mode:

```plaintext
gps-input tod-format cisco pps-input rs422
!
frequency synchronization
selection input
priority 2
wait-to-restore 0
ssm disable
quality receive exact itu-t option 2 generation 2 PPS
!

PTP Hybrid Mode: Example

This example shows the configuration of PTP hybrid mode:

```

```plaintext
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 timeout 2
    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
  !
  transceiver permit pid all
```

This example shows the output from the `show frequency synchronization` command:

```
RP/0/RSP0/CP00:router# show frequency synchronization selection

Node 0/RSP0/CP00:------------------
Selection point: T0-SEL-B (3 inputs, 1 selected)
  Last programmed 18h30m ago, and selection made 4h30m 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 GigabitEthernet0/1/1/0 0/1/CP00 SPA_RXOMUX 1 STU 10 Locked
PTP [0/RSP0/CP00] n/a ST3E 100 Available
Internal0 [0/RSP0/CP00] n/a ST3E 255 Available

Selection point: CHASSIS-TOD-SEL (2 inputs, 1 selected)
  Last programmed 18h30m ago, and selection made 4h30m ago
  Next selection points
    SPA scoped : None
    Node scoped : None
```

This example shows the output from the `show frequency synchronization` command:
### Additional References

The following sections provide references related to implementing PTP 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 PTP commands</td>
<td>PTP Commands module of Cisco ASR 9000 Series Aggregation Services Router System Management Command Reference</td>
</tr>
<tr>
<td>Cisco IOS XR SyncE commands</td>
<td>Frequency Synchronization Commands module of Cisco ASR 9000 Series Aggregation Services Router System Management Command Reference</td>
</tr>
<tr>
<td>Cisco IOS XR SyncE configuration information</td>
<td>Configuring Ethernet Interfaces module of Cisco ASR 9000 Series Aggregation Services Router Interface and Hardware Component Configuration Guide</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 Cisco ASR 9000 Series Aggregation Services Router System Security Configuration 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>
<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>
<td>—</td>
</tr>
</tbody>
</table>

### RFCs

<table>
<thead>
<tr>
<th>RFCs</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>RFC 1588</td>
<td><em>Standard for a Precision Clock Synchronization Protocol for Networked Measurement and Control Systems, 2008</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>
Implementing OnePK

One Platform Kit (onePK) is a cross platform API and software development kit that enables the user to develop applications that interact directly with Cisco networking devices, and provides the user with the ability to access networking services using a set of controlled APIs that share the same programming model and style.

This module has details about OnePK - concepts and configurations. For information on the relevant commands, refer the Cisco ASR 9000 Series Aggregation Services Router System Management Command Reference.

Table 27: Feature History for Implementing OnePKCisco 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>

- Information About onePK, page 261
- Service sets, page 264
- Hosting Models, page 265
- OnePK Transport, page 266
- Data Path Service Set, page 266
- Developing OnePK applications, page 267
- Enabling onePK, page 269
- Example: 1P Data Path configuration, page 271

Information About onePK

One Platform Kit (onePK) is a cross platform API and software development kit that enables the user to develop applications that interact directly with Cisco networking devices, and provides the user with the ability to access networking services using a set of controlled APIs that share the same programming model and style.
You can deploy onePK applications on a server in the network, such as a multi-CPU or multi-core server running Linux or Windows, or even a mobile device running Android or iOS. This is referred to as end-node hosting. The other hosting models are also discussed, in the later sections.

The base service set comprises all those services that an application needs to interact with Cisco devices. There are optional service sets that the application can use if it needs a specific service. The goal of onePK is to keep a consistent set of APIs across platforms so that customers can freely use any platform to develop their applications.

OnePK supports the following programming languages:

- C language API support
- Java language API support (Data Path service set is not supported in Java)
- Python API support

**Understanding the OnePK system architecture**

The onePK framework provides a client side application SDK to access the networking services running on Cisco devices. Enabling onePK on a Cisco platform requires that the platform be enabled to support the onePK abstraction side layer. The onePK enabled platforms make the onePK services accessible on that device when an application interacts with that device through the client side SDK.
This figure shows that applications can be built in multiple languages and can connect to different implementations.

Figure 4: The OnePK system

---

**Supported Platforms and Linecards**

The onePK is supported on the following linecards on the Cisco ASR 9000 Series Router:

- A9K-RSP440-SE RSP3 (for service edge)
- A9K-RSP440-TR RSP3 (for transport)
- A9K-2X100GE-SE= ASR 9000 2-port 100GE, Service Edge Optimized LC
- A9K-2X100GE-TR= ASR 9000 2-port 100GE, Packet Transport Optimized LC
- A9K-24X10GE-SE= ASR 9000 24-port 10GE, Service Edge Optimized LC
- A9K-24X10GE-TR= ASR 9000 24-port 10GE, Packet Transport Optimized LC
- A9K-MOD80-SE= ASR 9000 80G Modular LC, 2x Typhoon NPs, Service Edge Optimized
- A9K-MOD80-TR= ASR 9000 80G Modular LC, 2x Typhoon NPs, Packet Transport Optimized
- A9K-MOD160-SE= ASR 9000 160G Modular LC, 4x Typhoon NPs, Service Edge Optimized
- A9K-MOD160-TR= ASR 9000 160G Modular LC, 4x Typhoon NPs, Packet Transport Optimized
- A9K-MPA-2X10GE= ASR 9000 2-port 10GE Modular Port Adapter (XFP)
Supported Actions

These are the supported actions for onePK:

- drop
- offload
- redirect (IPv4 only)
- set next-hop (IPv4 only)
- Forwarding class mapped to a TE tunnel
- Rate limit
- QoS Marking
- Multiple actions per flow

Service sets

OnePK supports a variety of networking APIs using service sets. The base service set provided includes all of the following:

- Data Path Service Set:
  - Packet/Flow Classifiers
  - Punt
  - Inject
  - Statistics

- Policy Service Set:
  - Interface Policy
  - Interface Feature Policy
  - Forwarding Policy
  - Flow Action Policy

- Routing Service Set:
  - Protocol Change Events
Hosting Models

Application developers can deploy their applications in three different hosting models. Each model is designed to be source code portable. These are the three models:

• Process hosting enables application developers to install and run applications within a network element. This provides low latency communication and a single footprint for applications. All ONE-P applications are run in a process container.

• Blade hosting enables an application to run close to the control and data planes and have dedicated resources to perform tasks.
End node hosting enables applications to take advantage of industry platforms ranging from large compute intensive devices such as multi-cpu/multi-core servers running to compact mobile devices.

OnePK Transport

You can either use, Secure Sockets Layer (SSL) or Transport Layer Security (TLS) with onep applications to secure communication between your applications and connected devices to avoid onep credentials being sent over the network unencrypted.

For details about SSL, refer the Implementing SSL chapter in the Cisco ASR 9000 Series Aggregation Services Router System Security Configuration Guide.

To use TLS:

**Figure 5:**

Use the `transport type tls disable-remotecert-validation` command for device authentication. For bidirectional device support and oneP application authentication (client authentication), use the `transport type tls` command.

When using TLS, the network device is the TLS server and is authenticated with a certificate. The certificate must be issued by a Certification Authority (CA). It can be a private or a public certificate.

Data Path Service Set

The ONE-P Data Path Service Set (DPSS) presents a set of APIs to the end-developer. The user can work with packets that are diverted or copied from the forwarding path of a network element, such as a switch or router. It also enables the end-developer to re-inject diverted packets to the forwarding path of the network element after (optional) modification or synthesize new packets and inject them.

With this service set, your application can perform the following operations on packets:

- Divert— The packet is sent to the application and does not continue on its way until the packet is returned to the data path by the application. While the application is examining the packet and deciding what to do, no other application, including the host platform itself, can do anything with the packet. The application can modify the packet in any way it sees fit, including dropping it.

---

**Note**

IPv6 is not supported on DPSS for the Cisco ASR 9000 series routers.

Data Path Service Set Components

The Data Path Service Set (DPSS) is the service set used by developers to get access to packets punted or copied from the host platform's data path. The main DPSS components are:

- The **Common Flow Table** (CFT), is a shared memory implementation of a flow table that provides flow mapping, flow status and ways to manage application-specific flow feature objects. The CFT
functionality can be accessed by any 1P(oneP) application through the flow awareness part of the presentation layer. The Main Process Packet handling initially populates the CFT entry for a specific flow. The CFT is also responsible for propagating flow state changes initiated by a 1P application, back to the host platform's CFT (if there are changes).

• The Packet Manager is a shared memory component that provides the infrastructure to allow the DPSS to move packets between the platform and 1P applications while minimizing the number of copies, etc. Main Process Packet Processing will initially create the shared buffers for incoming packets. These will be accessed by various end-developer applications.

**DPSS flows**

The available flow actions are (in that order):

1. Drop flow
2. Redirected flow
3. Bypass flow

**Developing OnePK applications**

This procedure guides you to develop onep applications using linux. You will need to use a sample application to connect to a network device and verify your installation. The sample applications are:

• HelloElement—an application that connects to a network element, obtains the host name, then terminates.

• HelloNetwork—an application that connects to a network, obtains the host name, then terminates.
• SyslogDemo—an application that connects to a network element and discovers further network elements using Cisco Discovery Protocol (CDP).

Figure 6: Developing OnePK applications with Linux
Enabling onePK

Perform this task to enable onePK.

Note
Once the onep session is up, DPSS configuration is done from the application on the controller end.

SUMMARY STEPS

1. configure
2. onep
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></td>
</tr>
<tr>
<td><strong>Step 2</strong> onep</td>
<td>Enters the onep configuration mode and enables onep. All onePK attributes and parameters are configured in this submode.</td>
</tr>
</tbody>
</table>
| Example:  
RP/0/RSP0:router (config) # onep | |
| **Step 3** commit | |

Configuring onePK

This procedure describes the steps involved in configuring the various onePK parameters.

The onePK commands used in this configuration procedure, are discussed in detail in the *Cisco ASR 9000 Series Aggregation Services Router System Management Command Reference*. 
SUMMARY STEPS

1. configure
2. onep
3. Use one of these commands:
   - `session max value`
   - `service set name`
   - `transport`
   - `logging`
   - `cpu threshold rising`
   - `history size`
4. exit
5. 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>Enables and enters the onePK configuration mode.</td>
</tr>
<tr>
<td><strong>Step 2</strong> onep</td>
<td>Enables and enters the onePK configuration mode.</td>
</tr>
<tr>
<td>Example: RP/0/RSP0/CPU0:router (config) # onep</td>
<td>Enables and enters the onePK configuration mode.</td>
</tr>
<tr>
<td><strong>Step 3</strong> Use one of these commands:</td>
<td>Configures the limit for the selected onePK parameter.</td>
</tr>
<tr>
<td>Step 3 Use one of these commands:</td>
<td>Configures the limit for the selected onePK parameter.</td>
</tr>
<tr>
<td>- <code>session max value</code></td>
<td>Note: This step can be repeated to configure all the required parameters.</td>
</tr>
<tr>
<td>- <code>service set name</code></td>
<td></td>
</tr>
<tr>
<td>- <code>transport</code></td>
<td></td>
</tr>
<tr>
<td>- <code>logging</code></td>
<td></td>
</tr>
<tr>
<td>- <code>cpu threshold rising</code></td>
<td></td>
</tr>
<tr>
<td>- <code>history size</code></td>
<td></td>
</tr>
<tr>
<td>Example: RP/0/RSP0/CPU0:router(config-onep) # session max 10</td>
<td>Configures the limit for the selected onePK parameter.</td>
</tr>
<tr>
<td><strong>Step 4</strong> exit</td>
<td>Exits from the current mode.</td>
</tr>
<tr>
<td>Example: RP/0/RSP0/CPU0:router(config-onep) # exit</td>
<td>Exits from the current mode.</td>
</tr>
<tr>
<td><strong>Step 5</strong> commit</td>
<td></td>
</tr>
</tbody>
</table>
Example: 1P Data Path configuration

This example shows the Data Path configuration details:

```plaintext
onep
    transport tcp port 15001
    datapath transport vpathudp sender-id 1
```

To check for the running service node:

```plaintext
show run int gigEth 0/0/0/0
    service-policy type pbr input onep-pmap-1

service-node ONEP_1
    destination-port 19999 --> LOCAL_PORT from dpss.conf
    encapsulation udp
    source-port 6633
    service-endpoint-ip 192.168.2.102 --> LOCAL_IP from dpss.conf
    my-sender-id 1
    endpoint-sender-id 1
```
Example: 1P Data Path configuration
Implementing Open Flow Agent

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. This module has details about the Open Flow Agent, relevant concepts and configurations.

Table 28: 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, page 274
- OpenFlow Agent Packet In and Out Feature, page 277
- OpenFlow Agent with NetFlow Collection and Analytics, page 277
- OFA on Cisco Routers and Switches, page 278
- Functional Components, page 279
- OFA on ASR 9000 series routers, page 279
- OFA on OnePK, page 279
- OpenFlow Matches, page 279
- OpenFlow Actions, page 282
- Cisco Extension Actions, page 284
- Set Field Actions, page 284
- Configuring OneP for Openflow, page 287
- Configuring a Layer 2 Logical Switch for the OpenFlow Agent, page 287
- Configuring a Layer 2_Layer 3 Logical Switch for the OpenFlow Agent, page 289
- Configuring a Layer 3_VRF Logical Switch for the OpenFlow Agent, page 290
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 Cisco ASR 9000 Series Aggregation Services Router System Management Configuration Guide.

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-mls 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 29: OpenFlow Table Types

<table>
<thead>
<tr>
<th>Table Type</th>
<th>Pipeline</th>
<th>Supported Interfaces</th>
<th>Description</th>
</tr>
</thead>
</table>
| L2         | 129      | Bridge-domain, Gigabit ethernet, Bundle, Bundle-subinterfaces, PWHE-subinterfaces | • Supports L2 header matches.  
• Supports L2 actions.  
• Can be applied to the ingress L2 interfaces. |
| L2_L3      | 130      | Bridge-domain, Gigabit ethernet, Bundle, Bundle-subinterfaces, PWHE-subinterfaces | • Supports L2 and L3 (IPv4/IPv6) header matches.  
• Supports L2 actions.  
• Can be applied to the ingress L2 interfaces. |
| L3_V4      | 131      | VRF and global interfaces, BV1 (ipv4 only), Bridge-domain, Gigabit ethernet, Bundle, Bundle-subinterfaces | • Supports L3 (IPv4) header matches.  
• Supports L3 (IPv4) actions.  
• Can be applied to the ingress L3 interfaces. |
| L3_DS      | 132      | VRF and global interfaces, BV1, Bridge-domain, Gigabit ethernet, Bundle, Bundle-subinterfaces | • Supports L2 and L3 (IPv4/IPv6) header matches.  
• Supports L3 (IPv4/IPv6) actions.  
• Can be applied to the ingress 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
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
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 versions 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:

- Native dedicated CLI and troubleshooting
- High Availability
<table>
<thead>
<tr>
<th>OpenFlow Matches</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>OFPXMT_OFB_IN_PORT</td>
<td>Switch input port</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>OFPXMT_OFB_IN_PHY_PORT</td>
<td>Switch physical port</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>OFPXMT_OFB_METADATA</td>
<td>Metadata passed between tables</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>OFPXMT_OFB_ETH_DST</td>
<td>Ethernet destination address</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>OFPXMT_OFB_ETH_SRC</td>
<td>Ethernet source address</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>OFPXMT_OFB_ETH_TYPE</td>
<td>Ethernet frame type</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>OFPXMT_OFB_VLAN_VID</td>
<td>VLAN ID</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>OFPXMT_OFB_VLAN_PCP</td>
<td>VLAN priority</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>OFPXMT_OFB_IP_DSCP</td>
<td>IP DSCP (6 bits in ToS field)</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>OFPXMT_OFB_IP_ECN</td>
<td>IP ECN (2 bits in ToS field)</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>OFPXMT_OFB_IP_PROTO</td>
<td>IP protocol</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>OFPXMT_OFB_IPV4_SRC</td>
<td>IPv4 source address</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>OFPXMT_OFB_IPV4_DST</td>
<td>IPv4 destination address</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>OFPXMT_OFB_TCP_SRC</td>
<td>TCP source port</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>OpenFlow Matches</td>
<td>OpenFlow Switch Types Supported on ASR9K</td>
<td>Applied to L2 Bridge domain</td>
<td>Applied to L3 or L3 VRF interface</td>
</tr>
<tr>
<td>------------------</td>
<td>------------------------------------------</td>
<td>-------------------------------</td>
<td>----------------------------------</td>
</tr>
<tr>
<td>OFPXMT_OFB_TCP_DST</td>
<td>TCP destination port</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>OFPXMT_OFB_UDP_SRC</td>
<td>UDP source port</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>OFPXMT_OFB_UDP_DST</td>
<td>UDP destination port</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>OFPXMT_OFB_SCTP_SRC</td>
<td>SCTP source port</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>OFPXMT_OFB_SCTP_DST</td>
<td>SCTP destination port</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>OFPXMT_OFB_ICMPV4_TYPE</td>
<td>ICMP type</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>OFPXMT_OFB_ICMPV4_CODE</td>
<td>ICMP code</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>OFPXMT_OFB_ARP_OP</td>
<td>ARP opcode</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>OFPXMT_OFB_ARP_SPA</td>
<td>ARP source IPv4 address</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>OFPXMT_OFB_ARP_TPA</td>
<td>ARP target IPv4 address</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>OFPXMT_OFB_ARP_SHA</td>
<td>ARP source hardware address</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>OFPXMT_OFB_ARP_THA</td>
<td>ARP target hardware address</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>OFPXMT_OFB_IPV6_SRC</td>
<td>IPv6 source address</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>OFPXMT_OFB_IPV6_DST</td>
<td>IPv6 destination address</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>OFPXMT_OFB_IPV6_FLABEL</td>
<td>IPv6 Flow Label</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>OFPXMT_OFB_ICMPV6_TYPE</td>
<td>ICMPv6 type</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>OFPXMT_OFB_ICMPV6_CODE</td>
<td>ICMPv6 code</td>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>
OpenFlow Matches | OpenFlow Switch Types Supported on ASR9K
---|---
| Applied to L2 Bridge domain | Applied to L3 or L3 VRF interface

| OFPXMT_OFB_IPV6 ND TARGET | Target address for ND | No | No | No | No |
| OFPXMT_OFB_IPV6 ND SLL | Source link-layer for ND | No | No | No | No |
| OFPXMT_OFB_IPV6 ND TLL | Target link-layer for ND | No | No | No | No |
| OFPXMT_OFB_MPLS_LABEL | MPLS label | No | No | No | No |
| OFPXMT_OFB_MPLS TC | MPLS TC | No | No | No | No |
| OFPXMT_OFB_MPLS_BOS | MPLS BoS bit | No | No | No | No |
| OFPXMT_OFB_PBB ISID | PBB I-SID | No | No | No | No |
| OFPXMT_OFB_TUNNEL_ID | Logical Port Metadata | No | No | No | No |
| OFPXMT_OFB_IPV6 EXTHDR | IPv6 Extension Header pseudo-field | No | No | No | No |

### OpenFlow Actions

Packet forwarding and packet modification types of actions are supported. The lists of actions are always immediately applied to the packet.

**Note**

- 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>L2 only</td>
<td>L2_L3</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>
</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></td>
<td>Applied to L2 Bridge domain</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 ARP target IPv4 address</td>
<td>No</td>
</tr>
<tr>
<td>OFPXMT_OFB_ARP_SHA ARP source hardware address</td>
<td>No</td>
</tr>
<tr>
<td>OFPXMT_OFB_ARP_THA ARP target hardware address</td>
<td>No</td>
</tr>
<tr>
<td>OFPXMT_OFB_IPV6_SRC IPv6 source address</td>
<td>No</td>
</tr>
<tr>
<td>OFPXMT_OFB_IPV6_DST IPv6 destination address</td>
<td>No</td>
</tr>
<tr>
<td>OFPXMT_OFB_IPV6_FLABEL IPv6 Flow Label</td>
<td>No</td>
</tr>
<tr>
<td>OFPXMT_OFB_ICMPV6_TYPE ICMPv6 type</td>
<td>No</td>
</tr>
<tr>
<td>OFPXMT_OFB_ICMPV6_CODE ICMPv6 code</td>
<td>No</td>
</tr>
<tr>
<td>OFPXMT_OFB_IPV6_ND_TARGET Target address for ND</td>
<td>No</td>
</tr>
<tr>
<td>OFPXMT_OFB_IPV6_ND_SLL Source link-layer for ND</td>
<td>No</td>
</tr>
<tr>
<td>OFPXMT_OFB_IPV6_ND_TLL Target link-layer for ND</td>
<td>No</td>
</tr>
<tr>
<td>OFPXMT_OFB_MPLS_LABEL MPLS label</td>
<td>No</td>
</tr>
<tr>
<td>OFPXMT_OFB_MPLS_TC MPLS TC</td>
<td>No</td>
</tr>
<tr>
<td>OFPXMT_OFB_MPLS_BOS MPLS BoS bit</td>
<td>No</td>
</tr>
<tr>
<td>OFPXMT_OFB_PBB_ISID PBB I-SID</td>
<td>No</td>
</tr>
<tr>
<td>OFPXMT_OFB_TUNNEL_ID Logical Port Metadata</td>
<td>No</td>
</tr>
<tr>
<td>OFPXMT_OFB_IPV6_EXTHDR IPv6 Extension Header pseudo-field</td>
<td>No</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>Enters the OneP configuration mode.</td>
</tr>
<tr>
<td>Step 2 onep</td>
<td>Example: RP/0/RSP0/CPU0:router (config) # onep</td>
</tr>
<tr>
<td>Step 3 datapath transport vpathudp sender-id number</td>
<td>Configures the virtual-path udp transport datapath for the specified sender-id.</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
# Implementing Open Flow Agent

## Configuring a Layer 2 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>Step 1</td>
<td>configure</td>
<td></td>
</tr>
<tr>
<td>Step 2</td>
<td>openflow</td>
<td>Enters the openflow configuration mode.</td>
</tr>
<tr>
<td></td>
<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>
<td>Enters the logical switch configuration mode. For L2-only switch, the pipeline number is 129.</td>
</tr>
<tr>
<td></td>
<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</td>
<td>Enters the TLS configuration mode. Configures the local and remote trustpoints.</td>
</tr>
<tr>
<td></td>
<td>remote-tp-name</td>
<td>Example: RP/0/RSP0/CPU0:router(config-openflow-switch)#</td>
</tr>
<tr>
<td></td>
<td></td>
<td>tls trust-point local tp1 remote tp2</td>
</tr>
<tr>
<td>Step 5</td>
<td>bridge-group SDN-id bridge-domain switch-id</td>
<td>Configures the bridge-domain for the openflow switch. For layer2, the bridge-domain can be configured in the openflow switch and the interfaces of the bridge-domain will be learnt by the openflow switch.</td>
</tr>
<tr>
<td></td>
<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>
<td>Configures the Openflow controller for the logical switch.</td>
</tr>
<tr>
<td></td>
<td>none]</td>
<td>Configures the Openflow controller for the logical switch. 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.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td>RP/0/RSP0/CPU0:router(config-openflow-switch)# controller ipv4 5.0.1.1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>port 6633 security tls</td>
</tr>
<tr>
<td>Step 7</td>
<td>commit</td>
<td>Adds the Layer 2 logical switch configuration for the OpenFlow agent to</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td>the running configuration.</td>
</tr>
<tr>
<td>Step 8</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.

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>Step 1</td>
<td>configure</td>
</tr>
<tr>
<td>Step 2</td>
<td>openflow</td>
</tr>
<tr>
<td></td>
<td>Enters the openflow configuration mode.</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></td>
<td>Enters the logical switch configuration mode. For L2_L3 switch, the pipeline number is 130.</td>
</tr>
<tr>
<td>Example:</td>
<td>RP/0/RSP0/CPU0:router(config-openflow)# switch 1 pipeline 130</td>
</tr>
<tr>
<td>Step 4</td>
<td>tls trust-point local local-tp-name remote remote-tp-name</td>
</tr>
<tr>
<td></td>
<td>Enters the TLS configuration mode. Configures the local and remote trustpoints.</td>
</tr>
<tr>
<td>Example:</td>
<td>RP/0/RSP0/CPU0:router(config-openflow-switch)# tls trust-point local tpi remote tp2</td>
</tr>
<tr>
<td>Step 5</td>
<td>bridge-group SDN-id bridge-domain switch-id</td>
</tr>
<tr>
<td></td>
<td>Configures a bridge-domain for the openflow switch.</td>
</tr>
<tr>
<td>Example:</td>
<td>RP/0/RSP0/CPU0:router (config-openflow) # bridge-group SDN-1 bridge-domain of2</td>
</tr>
</tbody>
</table>
### 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>Step 1</td>
<td>configure</td>
<td>Purpose</td>
</tr>
<tr>
<td>Step 2</td>
<td>openflow</td>
<td>Enters the openflow configuration mode.</td>
</tr>
<tr>
<td>Example:</td>
<td>RP/0/RSP0/CPU0:router(config)# openflow</td>
<td></td>
</tr>
<tr>
<td>Step 3</td>
<td>switch</td>
<td>Enters the logical switch configuration mode. For L3 V4(VRF) switch, the pipeline number is 131.</td>
</tr>
<tr>
<td>Example:</td>
<td>RP/0/RSP0/CPU0:router(config-openflow)# switch 1 pipeline 131</td>
<td></td>
</tr>
<tr>
<td>Step 4</td>
<td>vrf IPv4</td>
<td>VRF configuration. All the interfaces belonging to IPv4 VRF will be learnt by the openflow switch.</td>
</tr>
<tr>
<td>Example:</td>
<td>RP/0/RSP0/CPU0:router(config)# vrf IPv4</td>
<td></td>
</tr>
<tr>
<td>Step 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>Example:</td>
<td>RP/0/RSP0/CPU0:router(config-openflow-switch)# tls trust-point local tp1 remote tp2</td>
<td></td>
</tr>
<tr>
<td>Step 6</td>
<td>controller ipv4 ip-address security [tls</td>
<td>Configures the Openflow controller for the logical switch.</td>
</tr>
<tr>
<td>Example:</td>
<td>5.0.1.1 port 6633 security tis</td>
<td>Configures the Openflow controller for the logical switch.</td>
</tr>
<tr>
<td></td>
<td>controller ipv4 5.0.1.1 port 6633 security tis</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></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.</td>
</tr>
<tr>
<td>Step 7</td>
<td>commit</td>
<td>Adds the Layer 2 logical switch configuration for the OpenFlow agent to the running configuration.</td>
</tr>
<tr>
<td>Example:</td>
<td>RP/0/RSP0/CPU0:router(logical-switch)# commit</td>
<td></td>
</tr>
<tr>
<td>Step 8</td>
<td>commit</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

### 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><strong>Purpose</strong> Enters the openflow configuration mode.</td>
</tr>
<tr>
<td><strong>Step 2</strong> openflow</td>
<td><strong>Example</strong>: RP/0/RSP0/CPU0:router(config)# openflow</td>
</tr>
<tr>
<td><strong>Step 3</strong> switch switch -id pipeline pipeline-number</td>
<td><strong>Example</strong>: RP/0/RSP0/CPU0:router(config-openflow)# switch 1 pipeline 132</td>
</tr>
<tr>
<td><strong>Step 4</strong> interface type interface-path-id</td>
<td><strong>Purpose</strong> Interface configuration. <strong>Note</strong> VRFs can be configured here. Both IPv4 abd IPv6 VRFs are supported.</td>
</tr>
<tr>
<td><strong>Step 5</strong> tls trust-point local local-tp-name remote remote-tp-name</td>
<td><strong>Example</strong>: RP/0/RSP0/CPU0:router(config-openflow-switch)# tls trust-point local tp1 remote tp2</td>
</tr>
<tr>
<td><strong>Step 6</strong> bridge-group SDN-id bridge-domain switch-id</td>
<td><strong>Purpose</strong> Enters the TLS configuration mode. Configures the local and remote trustpoints.</td>
</tr>
</tbody>
</table>
Implementing Open Flow 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><strong>Step 1</strong> configure</td>
<td></td>
</tr>
<tr>
<td><strong>Step 2</strong> openflow switch logical-switch-id</td>
<td>Enters the OpenFlow logical switch configuration mode.</td>
</tr>
</tbody>
</table>

Example:

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

```
RP/0/RSP0/CPU0:router(config)# openflow switch 100
```
### Implementing OpenFlow Agent

<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 3</td>
<td><code>tls trust-point local local-tp-name remote remote-tp-name</code></td>
<td>Enters the TLS configuration mode. Configures the local and remote trustpoints.</td>
</tr>
<tr>
<td></td>
<td><strong>Example:</strong> <code>RP/0/RSP0/CPU0:router(config-openflow-switch)# tls trust-point local tp1 remote tp2</code></td>
<td></td>
</tr>
<tr>
<td>Step 4</td>
<td><code>commit</code></td>
<td>Adds the logical switch configuration for the OpenFlow agent to the running configuration.</td>
</tr>
<tr>
<td></td>
<td><strong>Example:</strong> <code>RP/0/RSP0/CPU0:router(config-openflow-switch)# commit</code></td>
<td></td>
</tr>
<tr>
<td>Step 5</td>
<td><code>end</code></td>
<td>Exits logical switch configuration mode and enters EXEC mode.</td>
</tr>
<tr>
<td></td>
<td><strong>Example:</strong> <code>RP/0/RSP0/CPU0:router(config-openflow-switch)# end</code></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>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1</td>
<td>configure</td>
<td>Enters flow exporter map configuration mode.</td>
</tr>
<tr>
<td>Step 2</td>
<td>flow exporter-map <em>fem-name</em></td>
<td>Enters flow exporter map configuration mode.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td>Note: A single flow monitor map can support up to eight exporters.</td>
</tr>
<tr>
<td></td>
<td>RP/0/RSP0/CPU0:router(config)# flow</td>
<td></td>
</tr>
<tr>
<td></td>
<td>exporter-map fem</td>
<td></td>
</tr>
<tr>
<td>Step 3</td>
<td>destination <em>location</em></td>
<td>Configures the export destination for the flow exporter map. The</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td>destination <em>location</em> argument can be a hostname or an IP address.</td>
</tr>
<tr>
<td></td>
<td>RP/0/RSP0/CPU0:router(config-fem)#</td>
<td></td>
</tr>
<tr>
<td></td>
<td>destination 10.0.1.2</td>
<td></td>
</tr>
<tr>
<td>Step 4</td>
<td>version v9</td>
<td>Specifies export version parameters and enters the flow exporter map</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td>version configuration mode.</td>
</tr>
<tr>
<td></td>
<td>RP/0/RSP0/CPU0:router(config-fem)#</td>
<td></td>
</tr>
<tr>
<td></td>
<td>version v9</td>
<td></td>
</tr>
<tr>
<td>Step 5</td>
<td>commit</td>
<td>Commits the configuration changes to running to the running</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td>configuration.</td>
</tr>
<tr>
<td></td>
<td>RP/0/RSP0/CPU0:router(config-fem-ver)#</td>
<td></td>
</tr>
<tr>
<td></td>
<td>commit</td>
<td></td>
</tr>
<tr>
<td>Step 6</td>
<td>exit</td>
<td>Exits flow exporter map version configuration mode and enters</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td>global configuration mode.</td>
</tr>
<tr>
<td></td>
<td>RP/0/RSP0/CPU0:router(config-fem-ver)#</td>
<td></td>
</tr>
<tr>
<td></td>
<td>exit</td>
<td></td>
</tr>
<tr>
<td>Step 7</td>
<td>flow monitor-map <em>map-name</em></td>
<td>Creates a monitor map and configures a monitor map name and enters</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td>flow monitor map configuration mode</td>
</tr>
<tr>
<td></td>
<td>RP/0/RSP0/CPU0:router(config)# flow</td>
<td></td>
</tr>
<tr>
<td></td>
<td>monitor-map mmap</td>
<td></td>
</tr>
<tr>
<td>Step 8</td>
<td>record ipv4</td>
<td>Configures the flow record map name for IPv4. By default, the</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td>originating autonomous system (AS) numbers are collected and</td>
</tr>
<tr>
<td></td>
<td>RP/0/RSP0/CPU0:router(config-fmm)#</td>
<td>exported.</td>
</tr>
<tr>
<td></td>
<td>record ipv4</td>
<td></td>
</tr>
<tr>
<td>Step 9</td>
<td>exporter <em>map-name</em></td>
<td>Associates an exporter map with a monitor map.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td>Note: A single flow monitor map can support up to eight exporters.</td>
</tr>
<tr>
<td></td>
<td>RP/0/RSP0/CPU0:router(config-fmm)#</td>
<td></td>
</tr>
<tr>
<td></td>
<td>exporter fmap</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>Step 10</strong></td>
<td>Cache entries number</td>
<td></td>
</tr>
<tr>
<td><strong>Example:</strong> RP/0/RSP0/CPU0:router(config-fmm)# cache entries 4096</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>
<td></td>
</tr>
<tr>
<td><strong>Step 11</strong></td>
<td>Cache timeout {active timeout-value</td>
<td>inactive timeout-value</td>
</tr>
<tr>
<td><strong>Example:</strong> RP/0/RSP0/CPU0:router(config-fmm)# cache timeout active 10</td>
<td>(Optional) Configures the active, inactive, or update flow cache timeout value.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• The default timeout value for the inactive flow cache is 15 seconds.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• The default timeout value for the active flow cache is 1800 seconds.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• The default timeout value for the update flow cache is 1800 seconds.</td>
<td></td>
</tr>
<tr>
<td><strong>Note</strong></td>
<td>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.</td>
<td></td>
</tr>
<tr>
<td><strong>Step 12</strong></td>
<td>Commit</td>
<td></td>
</tr>
<tr>
<td><strong>Example:</strong> RP/0/RSP0/CPU0:router(config-fmm)# commit</td>
<td>Commits the configuration changes to running to the running configuration.</td>
<td></td>
</tr>
<tr>
<td><strong>Step 13</strong></td>
<td>Exit</td>
<td></td>
</tr>
<tr>
<td><strong>Example:</strong> RP/0/RSP0/CPU0:router(config-fmm)# exit</td>
<td>Exits flow monitor map version configuration mode and enters global configuration mode.</td>
<td></td>
</tr>
<tr>
<td><strong>Step 14</strong></td>
<td>Sampler-map map-name</td>
<td></td>
</tr>
<tr>
<td><strong>Example:</strong> RP/0/RSP0/CPU0:router(config)# sampler-map</td>
<td>Creates a sampler map and enters sampler map configuration mode.</td>
<td></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>
<td></td>
</tr>
<tr>
<td><strong>Step 15</strong></td>
<td>Random 1 out-of sampling-interval</td>
<td></td>
</tr>
<tr>
<td><strong>Example:</strong> RP/0/RSP0/CPU0:router(config-sm)# random 1 out-of 65535</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>
<td></td>
</tr>
<tr>
<td><strong>Step 16</strong></td>
<td>Commit</td>
<td></td>
</tr>
<tr>
<td><strong>Example:</strong> RP/0/RSP0/CPU0:router(config-sm)# commit</td>
<td>Commits the configuration changes to running to the running configuration.</td>
<td></td>
</tr>
</tbody>
</table>
### Purpose

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 17</strong></td>
<td><strong>exit</strong></td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td><code>RP/0/RSP0/CPU0:router(config-sm)# exit</code></td>
</tr>
<tr>
<td><strong>Step 18</strong></td>
<td><strong>commit</strong></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.

### 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 l1 pipeline 131
  vrf IPv4
  controller ipv4 5.0.1.200 port 6653 security none
  ```

- L3_DS switch can be attached either to a VRF or directly to layer 3 interfaces under global VRF.

  ```
  openflow
  switch l2 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):
Use case 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.

Use case 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.
Usecase for Layer3
CHAPTER 15

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 30: Feature History for Configuring Manageability on Cisco IOS XR Software

<table>
<thead>
<tr>
<th>Release</th>
<th>Feature Description</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>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, page 302
- How to Configure Manageability, page 302
- Configuration Examples for Manageability, page 303
- Additional References, page 304
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>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1</td>
<td><code>xml agent [ssl]</code></td>
<td>Enables Extensible Markup Language (XML) requests over a dedicated TCP connection and enters XML agent configuration mode. Use the <code>ssl</code> keyword to enable XML requests over Secure Socket Layer (SSL).</td>
</tr>
<tr>
<td>Example:</td>
<td><code>RP/0/RSP0/CPU0:router# config)# xml agent</code></td>
<td></td>
</tr>
<tr>
<td>Step 2</td>
<td><code>iteration on size iteration-size</code></td>
<td>Configures the iteration size for large XML agent responses in KBytes. The default is 48.</td>
</tr>
<tr>
<td>Example:</td>
<td><code>RP/0/RSP0/CPU0:router(config)# iteration on size 500</code></td>
<td></td>
</tr>
<tr>
<td>Step 3</td>
<td><code>session timeout timeout</code></td>
<td>Configures an idle timeout for the XML agent in minutes. By default, there is no timeout.</td>
</tr>
<tr>
<td>Example:</td>
<td><code>RP/0/RSP0/CPU0:router(config)# session timeout 5</code></td>
<td></td>
</tr>
<tr>
<td>Step 4</td>
<td>`throttle {memory size</td>
<td>process-rate tags}`</td>
</tr>
</tbody>
</table>
### Command or Action

#### Example:

```
RP/0/RSP0/CPU0:router:router(config-xml-agent)# throttle memory 300
```

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Example:</td>
<td>• Specify the memory size in Mbytes. Values can range from 100 to 600. The default is 300.</td>
</tr>
<tr>
<td></td>
<td>• Specify the process-rate as the number of tags that the XML agent can process per second. Values can range from 1000 to 30000. By default the process rate is not throttled.</td>
</tr>
<tr>
<td>Step 5 vrf { default</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></td>
<td>vrf-name} [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:router(config-xml-agent)# vrf VRF1
RP/0/RSP0/CPU0:router:router(config-xml-agent)# 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:router(config-xml-agent)# 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:router(config-xml-agent)# vrf VRF1
RP/0/RSP0/CPU0:router:router(config-xml-agent)# 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:router(config-xml-agent)# 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>
</thead>
<tbody>
<tr>
<td>Cisco IOS XR commands</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 Cisco IOS XR Software module of Cisco ASR 9000 Series Aggregation Services Router System Security Configuration Guide</td>
</tr>
</tbody>
</table>

Standards and RFCs

<table>
<thead>
<tr>
<th>Standard/RFC</th>
<th>Title</th>
<th></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>
<td></td>
</tr>
</tbody>
</table>

MIBs

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

RFCs

<table>
<thead>
<tr>
<th>RFCs</th>
<th>Title</th>
<th></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>
<td></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. 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. 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 16

Configuring Call Home

This module describes the configuring of the Call Home feature.

Table 31: 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, page 308
- Configuring Call Home, page 312
- Configuring Contact Information, page 312
- Configuring and Activating Destination Profiles, page 314
- Associating an Alert Group with a Destination Profile, page 315
- Configuring Email, page 318
- Enabling Call Home, page 320
- Configuring Smart Call Home (single command), page 320
- Configuring Call Home Data Privacy, page 321
- Configuring Syslog Throttling, page 322
- Enabling AAA Authorization, page 322
- Sending Call Home Alert group Messages Manually, page 323
- Manually sending command output message for a Command List, page 324
- Configuring a HTTP Proxy Server, page 325
- Configuring Snapshot alert group, page 326
- Configuring Anonymous Reporting, page 327
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 32: Alert Groups and Executed Commands**

<table>
<thead>
<tr>
<th>Alert Group</th>
<th>Description</th>
<th>Executed Commands</th>
</tr>
</thead>
</table>
| Environmental | Events related to power, fan, and environment-sensing elements such as temperature alarms. | show environment  
show logging  
show inventory  
show environment trace  
show diag |
| Inventory     | Inventory status that is provided whenever a unit is cold booted, or when FRUs are inserted or removed. This alert is considered a noncritical event, and the information is used for status and entitlement. | admin show platform  
admin show version  
admin show diag  
admin show inventory oid |
| Syslog        | Events generated by specific interesting syslog messages                      | admin show version  
admin show logging  
admin show inventory |
| Configuration | User-generated request for configuration or configuration change event.       | • show version  
• show running config all  
• show inventory  
• show configuration history last 30  
• show configuration commit changes last 1 |
| Snapshot      | This alert group can be configured for periodic notifications                  | By default, this alert group has no commands to be run. You can add the required commands that need to be run. |
Call Home maps the syslog severity level to the corresponding Call Home severity level for syslog port group messages.

## Call Home Message Levels

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

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

---

**Note**

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

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

### Table 33: 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>
</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.

<table>
<thead>
<tr>
<th>Call Home Level</th>
<th>Keyword</th>
<th>syslog Level</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<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>
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-add 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></td>
<td>configure</td>
</tr>
<tr>
<td><strong>Step 2</strong></td>
<td>call-home</td>
</tr>
<tr>
<td>Example:</td>
<td>Enters call home configuration mode.</td>
</tr>
<tr>
<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>
</tr>
<tr>
<td><strong>Step 3</strong></td>
<td>contact-email-addr email-address</td>
</tr>
<tr>
<td>Example:</td>
<td>Configures the customer email address. Enter up to 200 characters in</td>
</tr>
<tr>
<td></td>
<td>email address format with no spaces.</td>
</tr>
<tr>
<td>RP/0/RSP0/CPU0:router(config-call-home)#</td>
<td></td>
</tr>
<tr>
<td></td>
<td>contact-email-addr</td>
</tr>
<tr>
<td></td>
<td><a href="mailto:user1@cisco.com">user1@cisco.com</a></td>
</tr>
<tr>
<td><strong>Step 4</strong></td>
<td>contract-id contract-id-string</td>
</tr>
<tr>
<td>Example:</td>
<td>(Optional) Configures the contract ID. Enter up to 64 characters. If</td>
</tr>
<tr>
<td></td>
<td>you include spaces, you must enclose the entry in quotes (&quot;&quot;).</td>
</tr>
<tr>
<td>RP/0/RSP0/CPU0:router(config-call-home)#</td>
<td></td>
</tr>
<tr>
<td></td>
<td>contract-id</td>
</tr>
<tr>
<td></td>
<td>Contract-identifier</td>
</tr>
<tr>
<td><strong>Step 5</strong></td>
<td>customer-id customer-id-string</td>
</tr>
<tr>
<td>Example:</td>
<td>(Optional) Configures the customer ID. Enter up to 64 characters. If</td>
</tr>
<tr>
<td></td>
<td>you include spaces, you must enclose the entry in quotes (&quot;&quot;).</td>
</tr>
<tr>
<td>RP/0/RSP0/CPU0:router(config-call-home)#</td>
<td></td>
</tr>
<tr>
<td></td>
<td>customer-id</td>
</tr>
<tr>
<td></td>
<td>Customer1</td>
</tr>
<tr>
<td><strong>Step 6</strong></td>
<td>phone-number phone-number-string</td>
</tr>
<tr>
<td>Example:</td>
<td>(Optional) Configures the customer phone number. The number must begin</td>
</tr>
<tr>
<td></td>
<td>with a plus (+) prefix, and may contain only dashes (-) and numbers.</td>
</tr>
<tr>
<td></td>
<td>Enter up to 16 characters.</td>
</tr>
<tr>
<td>RP/0/RSP0/CPU0:router(config-call-home)#</td>
<td></td>
</tr>
<tr>
<td></td>
<td>phone-number</td>
</tr>
<tr>
<td></td>
<td>+405-123-4567</td>
</tr>
<tr>
<td><strong>Step 7</strong></td>
<td>street-address street-address</td>
</tr>
<tr>
<td>Example:</td>
<td>(Optional) Configures the customer street address where RMA equipment</td>
</tr>
<tr>
<td></td>
<td>can be shipped. Enter up to 200 characters. If you include spaces, you</td>
</tr>
<tr>
<td></td>
<td>must enclose the entry in quotes (&quot;&quot;).</td>
</tr>
<tr>
<td>RP/0/RSP0/CPU0:router(config-call-home)#</td>
<td></td>
</tr>
<tr>
<td></td>
<td>street-address</td>
</tr>
<tr>
<td></td>
<td>&quot;300 E. Tasman Dr. San Jose, CA 95134&quot;</td>
</tr>
<tr>
<td><strong>Step 8</strong></td>
<td>site-id site-id-string</td>
</tr>
<tr>
<td>Example:</td>
<td>(Optional) Configures the site ID for the system. Enter up to 200</td>
</tr>
<tr>
<td></td>
<td>characters. If you include spaces, you must enclose the entry in quotes</td>
</tr>
<tr>
<td></td>
<td>(&quot;&quot;&quot;).</td>
</tr>
<tr>
<td>RP/0/RSP0/CPU0:router(config-call-home)#</td>
<td></td>
</tr>
<tr>
<td></td>
<td>site-id</td>
</tr>
<tr>
<td></td>
<td>SJ-RouterRoom1</td>
</tr>
<tr>
<td><strong>Step 9</strong></td>
<td>commit</td>
</tr>
</tbody>
</table>

---

Cisco ASR 9000 Series Aggregation Services Router System Management Configuration Guide, Release 5.1.x
### 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></td>
<td><strong>configure</strong></td>
</tr>
<tr>
<td><strong>Step 2</strong></td>
<td><strong>call-home</strong></td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td><strong>RP/0/RSP0/CPU0:router(config)# call-home</strong></td>
</tr>
<tr>
<td></td>
<td><strong>RP/0/RSP0/CPU0:router(config-call-home)#</strong></td>
</tr>
<tr>
<td><strong>Step 3</strong></td>
<td><strong>profile profile-name</strong></td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td><strong>RP/0/RSP0/CPU0:router(config-call-home)# profile my_profile</strong></td>
</tr>
<tr>
<td></td>
<td><strong>RP/0/RSP0/CPU0:router(config-call-home-profile)#</strong></td>
</tr>
</tbody>
</table>

**Example:**

`RP/0/RSP0/CPU0:router# show call-home`

**Purpose:**

- **Step 10**
  - `show call-home`
  - **Example:**
    - `RP/0/RSP0/CPU0:router# show call-home`
  - Displays information about the system contacts.
### Configuring Call Home

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 4</strong></td>
<td></td>
</tr>
<tr>
<td>destination address email email-address</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)#</td>
<td></td>
</tr>
<tr>
<td>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></td>
<td></td>
</tr>
<tr>
<td>destination message-size-limit max-size</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)#</td>
<td></td>
</tr>
<tr>
<td>destination message-size-limit 1000</td>
<td></td>
</tr>
<tr>
<td><strong>Step 6</strong></td>
<td></td>
</tr>
<tr>
<td>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)#</td>
<td></td>
</tr>
<tr>
<td>destination preferred-msg-format xml</td>
<td></td>
</tr>
<tr>
<td><strong>Step 7</strong></td>
<td></td>
</tr>
<tr>
<td>destination transport-method [ email</td>
<td>http ]</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>RP/0/RSP0/CPU0:router(config-call-home-profile)#</td>
<td></td>
</tr>
<tr>
<td>destination transport-method email</td>
<td></td>
</tr>
<tr>
<td><strong>Step 8</strong></td>
<td></td>
</tr>
<tr>
<td>active</td>
<td>Activates the destination profile.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>RP/0/RSP0/CPU0:router(config-call-home-profile)#</td>
<td></td>
</tr>
<tr>
<td>active</td>
<td></td>
</tr>
<tr>
<td><strong>Step 9</strong></td>
<td></td>
</tr>
<tr>
<td>commit</td>
<td></td>
</tr>
<tr>
<td><strong>Step 10</strong></td>
<td></td>
</tr>
<tr>
<td>show call-home profile { all</td>
<td>profile-name }</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>RP/0/RSP0/CPU0:router# show call-home profile all</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>configure</td>
</tr>
<tr>
<td><strong>Step 2</strong></td>
<td>call-home</td>
</tr>
</tbody>
</table>
| Example: | RP/0/RSP0/CPU0:router(config)# call-home
RP/0/RSP0/CPU0:router(config-call-home)# |
| **Step 3** | profile profile-name |
| Example: | RP/0/RSP0/CPU0:router(config-call-home)# profile my_profile
RP/0/RSP0/CPU0:router(config-call-home-profile)# |
| **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 |

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

- **catastrophic**—Includes network-wide catastrophic events in the alert. This is the highest severity.
- **critical**—Includes events requiring immediate attention (system log level 1).
- **disaster**—Includes events with significant network impact.
- **fatal**—Includes events where the system is unusable (system log level 0).
<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>subscribe-to-alert-group inventory</strong> periodic {daily</td>
<td>monthly day-of-month</td>
</tr>
<tr>
<td><strong>subscribe-to-alert-group syslog severity severity-level pattern string</strong></td>
<td>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.</td>
</tr>
</tbody>
</table>

**Example:**
```
RP/0/RSP0/CPU0:router(config-call-home-profile)#
subscribe-to-alert-group inventory periodic monthly 1 10:00
```

**Example:**
```
RP/0/RSP0/CPU0:router(config-call-home-profile)#
subscribe-to-alert-group syslog severity major pattern
```
<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 7</strong> subscribe-to-alert-group snapshot severity severity-level pattern string</td>
<td>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;). 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;).</td>
</tr>
<tr>
<td><strong>Example:</strong> RP/0/RSP0/CPU0:router(config-call-home-profile)# subscribe-to-alert-group snapshot severity major pattern</td>
<td></td>
</tr>
<tr>
<td><strong>Step 8</strong> 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;).</td>
</tr>
<tr>
<td><strong>Example:</strong> RP/0/RSP0/CPU0:router(config-call-home-profile)# subscribe-to-alert-group configuration severity major pattern</td>
<td></td>
</tr>
<tr>
<td><strong>Step 9</strong> 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>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> configure</td>
<td>Enlists call-home configuration mode.</td>
</tr>
<tr>
<td><strong>Step 2</strong> call-home</td>
<td>(Optional) Specifies the email message “from” address.</td>
</tr>
<tr>
<td>Example: RP/0/RSP0/CPU0:router(config)# call-home RP/0/RSP0/CPU0:router(config-call-home)#</td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong> sender from <em>email-address</em></td>
<td>(Optional) Specifies the email message “reply-to” address.</td>
</tr>
<tr>
<td>Example: 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><strong>Step 4</strong> sender reply-to <em>email-address</em></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>Example: 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><strong>Step 5</strong> mail-server <em>address</em> priority <em>priority</em></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>Example: RP/0/RSP0/CPU0:router(config-call-home)# mail-server 198.51.100.10 priority 1</td>
<td></td>
</tr>
<tr>
<td><strong>Step 6</strong> rate-limit <em>events-count</em></td>
<td>Displays the status of the specified mail server.</td>
</tr>
<tr>
<td>Example: RP/0/RSP0/CPU0:router(config-call-home)# rate-limit 4</td>
<td></td>
</tr>
<tr>
<td><strong>Step 7</strong> commit</td>
<td></td>
</tr>
<tr>
<td><strong>Step 8</strong> show call-home mail-server status</td>
<td></td>
</tr>
<tr>
<td>Example: RP/0/RSP0/CPU0:router# show call-home mail-server status</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></td>
<td>configure</td>
</tr>
<tr>
<td><strong>Step 2</strong></td>
<td>call-home</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>Enters call home configuration mode.</td>
</tr>
<tr>
<td>RP/0/RSP0/CPU0:router(config)# call-home RP/0/RSP0/CPU0:router(config-call-home)#</td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong></td>
<td>service active</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>Enables the sending of Call Home messages.</td>
</tr>
<tr>
<td>RP/0/RSP0/CPU0:router(config-call-home)# service active</td>
<td></td>
</tr>
<tr>
<td><strong>Step 4</strong></td>
<td>commit</td>
</tr>
</tbody>
</table>

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 ]
### Configuring Call Home

#### Purpose

Enables all call home basic configurations using a single command.

#### Command or Action

<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>call-home reporting { anonymous</td>
<td>contact-email email-address } [ http-proxy { address } port port-number ]</td>
</tr>
</tbody>
</table>

Example:
```
RP/0/RSP0/CPU0:router (config) # call-home reporting
contact-email email@company.com
```

### 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>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>call-home</td>
<td>Enters the call home configuration submode.</td>
</tr>
</tbody>
</table>

Example:
```
RP/0/RSP0/CPU0:router(config) #
call-home
```

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

Example:
```
RP/0/RSP0/CPU0:router(config-call-home) #
data-privacy level high
```

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

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

**Note** Enabling the data-privacy command can affect CPU utilization when scrubbing a large amount of data.
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><strong>Step 1</strong></td>
<td>configure</td>
</tr>
<tr>
<td><strong>Step 2</strong></td>
<td>call-home</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td><code>RP/0/RSP0/CPU0:router (config) # call-home</code></td>
</tr>
<tr>
<td><strong>Step 3</strong></td>
<td>syslog-throttling</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td><code>RP/0/RSP0/CPU0:router (config-call-home) # syslog-throttling</code></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]

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>
### Purpose

**Command or Action**

**Step 2**

Enters Call Home configuration mode.

**Example:**

```bash
RP/0/RSP0/CPU0:router (config) # call-home
```

**Step 3**

Enables AAA authorization. Specifies the username for authorization.

**Example:**

```bash
RP/0/RSP0/CPU0:router (config-call-home) # aaa-authorization username u1
```

### 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>
</table>
| **Step 1**<br>`call-home send alert-group snapshot [ profile name ]`
<br>`Example:`
<br>`RP/0/RSP0/CPU0:router # call-home send alert-group snapshot profile pl` | Sends a snapshot alert group message to one destination profile if specified or to all subscribed destination profiles. |
<table>
<thead>
<tr>
<th>Step 2</th>
<th>call-home send alert-group configuration [ profile name ]</th>
<th>Sends a configuration alert group message to one destination profile if specified or to all subscribed destination profiles.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Example:</td>
<td>RP/0/RSP0/CPU0:router # call-home send alert-group configuration profile p1</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Step 3</th>
<th>call-home send alert-group inventory [ profile name ]</th>
<th>Sends an inventory alert group message to one destination profile if specified or to all subscribed destination profiles.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Example:</td>
<td>RP/0/RSP0/CPU0:router # call-home send alert-group inventory profile p1</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# ]
### DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> `call-home send { cli command</td>
<td>cli list } { email email msg-format { long-text</td>
</tr>
</tbody>
</table>

- **cli command | cli list**—Specifies the command or list of commands (separated by ';'). It can be any run command, including commands for all modules. The commands must be contained in quotes ("").

- **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 email support@example.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 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><strong>Step 1</strong> configure</td>
<td></td>
</tr>
</tbody>
</table>
### Configuring Call Home

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 2</strong></td>
<td>Enters Call Home configuration mode.</td>
</tr>
<tr>
<td>call-home</td>
<td></td>
</tr>
</tbody>
</table>

**Example:**

```
RP/0/RSP0/CPU0:router (config) # call-home
```

<table>
<thead>
<tr>
<th>Purpose</th>
<th>Command or Action</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 3</strong></td>
<td>Configures the port for the specified HTTP proxy server. Range is 1 to 65535.</td>
</tr>
<tr>
<td>http-proxy proxy-server-name port port-number</td>
<td></td>
</tr>
</tbody>
</table>

**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><strong>Step 1</strong></td>
<td></td>
</tr>
<tr>
<td>configure</td>
<td>Enters snapshot configuration mode.</td>
</tr>
<tr>
<td><strong>Step 2</strong></td>
<td>Enters Call Home configuration mode.</td>
</tr>
<tr>
<td>call-home</td>
<td></td>
</tr>
</tbody>
</table>

**Example:**

```
RP/0/RSP0/CPU0:router (config) # call-home
```

<table>
<thead>
<tr>
<th>Purpose</th>
<th>Command or Action</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 3</strong></td>
<td>Enters snapshot configuration mode.</td>
</tr>
<tr>
<td>alert-group-configuration snapshot</td>
<td></td>
</tr>
</tbody>
</table>

**Example:**

```
RP/0/RSP0/CPU0:router (config-call-home) # alert-group-configuration snapshot
```

<table>
<thead>
<tr>
<th>Purpose</th>
<th>Command or Action</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 4</strong></td>
<td>Adds the command to the snapshot alert group.</td>
</tr>
<tr>
<td>add-command &quot;command string&quot;</td>
<td></td>
</tr>
</tbody>
</table>

**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>Step 1</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 2</td>
<td>configure</td>
<td>Enters Call Home configuration mode.</td>
</tr>
<tr>
<td>Example:</td>
<td>call-home</td>
<td></td>
</tr>
<tr>
<td>RP/0/RSP0/CPU0:router (config) # call-home</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Step 3</td>
<td>profile name</td>
<td>Enters the profile configuration mode.</td>
</tr>
<tr>
<td>Example:</td>
<td>profile ciscotac</td>
<td></td>
</tr>
<tr>
<td>RP/0/RSP0/CPU0:router (config-call-home) # profile ciscotac</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Step 4</td>
<td>anonymous-reporting-only</td>
<td>Enters anonymous mode. When anonymous-reporting-only is set, only inventory and test messages are sent.</td>
</tr>
<tr>
<td>Example:</td>
<td>anonymous-reporting-only</td>
<td></td>
</tr>
<tr>
<td>RP/0/RSP0/CPU0:router (config-call-home-profile) # anonymous-reporting-only</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

What to Do Next

•

Configuring Call Home to use VRF

SUMMARY STEPS

1. configure
2. call-home
3. vrf vrf-name
**Configuring 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 call home for the specified VRF. VRF works only for the http transport method. It does not work for the email transport method.</td>
</tr>
<tr>
<td><strong>Step 3</strong> vrf vrf-name</td>
<td></td>
</tr>
</tbody>
</table>

**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> configure</td>
<td>Enters Call Home configuration mode.</td>
</tr>
<tr>
<td><strong>Step 2</strong> call-home</td>
<td>Configures the source interface.</td>
</tr>
<tr>
<td><strong>Step 3</strong> source-interface type interface-path-id</td>
<td></td>
</tr>
</tbody>
</table>

**Note**

Source-interface supports email and HTTP messages.
CHAPTER 17

Implementing 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 340. 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 34: Feature History for Implementing Object Tracking

<table>
<thead>
<tr>
<th>Release</th>
<th>Modification</th>
</tr>
</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, page 329
- Information About Object Tracking, page 330
- How to Implement Object Tracking, page 330
- Configuration Examples for Configuring Object Tracking, page 340
- Additional References, page 340

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

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

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

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

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

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

How to Implement Object Tracking

This section describes the various object tracking procedures.

Tracking the Line Protocol State of an Interface

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

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

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

**SUMMARY STEPS**

1. configure
2. track track-name
3. type line-protocol state
4. interface type interface-path-id
5. exit
6. (Optional) delay {up seconds|down seconds}
7. Use one of the following commands:
   • end
   • commit
# DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> configure</td>
<td>Enters track configuration mode.</td>
</tr>
<tr>
<td><strong>Step 2</strong> track track-name</td>
<td>* track-name—Specifies a name for the object to be tracked.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>RP/0/RSP0/CPU0:router(config)# track track1</td>
</tr>
<tr>
<td><strong>Step 3</strong> type line-protocol state</td>
<td>Creates a track based on the line protocol of an interface.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>RP/0/RSP0/CPU0:router(config-track)# type line-protocol state</td>
</tr>
<tr>
<td><strong>Step 4</strong> interface type interface-path-id</td>
<td>Specifies the interface to track the protocol state.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>RP/0/RSP0/CPU0:router(config-track-line-prot)# interface atm 0/2/0/0.1</td>
</tr>
<tr>
<td></td>
<td>* type—Specifies the interface type. For more information, use the question mark (?) online help function.</td>
</tr>
<tr>
<td></td>
<td>* interface-path-id—Identifies a physical interface or a virtual interface.</td>
</tr>
<tr>
<td><strong>Note</strong> Use the <strong>show interfaces</strong> command to see a list of all possible interfaces currently configured on the router.</td>
<td></td>
</tr>
<tr>
<td><strong>Note</strong> The loopback and null interfaces are always in the up state and, therefore, cannot be tracked.</td>
<td></td>
</tr>
<tr>
<td><strong>Step 5</strong> exit</td>
<td>Exits the track line protocol configuration mode.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>RP/0/RSP0/CPU0:router(config-track-line-prot)# exit</td>
</tr>
<tr>
<td><strong>Step 6</strong> delay {up seconds</td>
<td>down seconds}</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>RP/0/RSP0/CPU0:router(config-track)# delay up 10</td>
</tr>
<tr>
<td><strong>Step 7</strong> Use one of the following commands:</td>
<td>Saves configuration changes.</td>
</tr>
<tr>
<td></td>
<td>* end</td>
</tr>
<tr>
<td></td>
<td>* commit</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>RP/0/RSP0/CPU0:router(config-track)# end or</td>
</tr>
<tr>
<td></td>
<td>RP/0/RSP0/CPU0:router(config-track)# commit</td>
</tr>
<tr>
<td><strong>Uncommitted changes found, commit them before exiting(yes/no/cancel)? [cancel]:</strong></td>
<td></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>
</tbody>
</table>
Purpose

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>enter</strong> no</td>
<td>Entering no exits the configuration session and returns the router to EXEC mode without committing the configuration changes.</td>
</tr>
<tr>
<td><strong>enter</strong> cancel</td>
<td>Entering cancel leaves the router in the current configuration session without exiting or committing the configuration changes.</td>
</tr>
<tr>
<td><strong>commit</strong></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>

---

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>configure</td>
<td></td>
</tr>
<tr>
<td>Step 2</td>
<td>track track-name</td>
<td>Enters track configuration mode.</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>Example:</strong> RP/0/RSP0/CPU0:router(config)# track track1</td>
<td><em>track-name</em>—Specifies a name for the object to be tracked.</td>
<td></td>
</tr>
</tbody>
</table>

**Step 3**

**type route reachability**

**Example:** RP/0/RSP0/CPU0:router(config-track)# type route reachability vrf internet

**Configures the routing process to notify the tracking process when the state of the route changes due to a routing update.**

**Step 4**

Use one of the following commands:

- **vrf vrf-table-name**
- **route ipv4 IP-prefix/mask**

**Example:**
- RP/0/RSP0/CPU0:router(config-track-route)# vrf vrf-table-4
- RP/0/RSP0/CPU0:router(config-track-route)# route ipv4 10.56.8.10/16

**Configures the type of IP route to be tracked, which can consist of either of the following, depending on your router type:**

- **vrf-table-name**—A VRF table name.
- **IP-prefix/mask**—An IP prefix consisting of the network and subnet mask (for example, 10.56.8.10/16).

**Step 5**

**exit**

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

**Exits the track line protocol configuration mode.**

**Step 6**

**delay {up seconds|down seconds}**

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

**(Optional) Schedules the delay that can occur between tracking whether the object is up or down.**

**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.
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 objectpolls the interface for its state.

**SUMMARY STEPS**

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

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1 configure</td>
<td>Enters track configuration mode.</td>
</tr>
<tr>
<td>Step 2 track track-name</td>
<td>• track-name—Specifies a name for the object to be tracked.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>RP/0/RSP0/CPU0:router(config)# track track1</td>
<td></td>
</tr>
<tr>
<td>Step 3 type list boolean { and</td>
<td>or }</td>
</tr>
<tr>
<td>Example:</td>
<td>• boolean—Specifies that the state of the tracked list is based on a Boolean calculation.</td>
</tr>
<tr>
<td>RP/0/RSP0/CPU0:router(config-track-list)# type list boolean and</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>• 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>
</tbody>
</table>
### Building a Track Based on a List of Objects - Threshold Percentage

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

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
</table>
| **Step 4** | object **object-name** [ not ]
| Example: | RP/0/RSP0/CPU0:router(config-track-list)# object 3 not |
| Purpose | Specifies the object to be tracked by the list |
| | - **object-name** — Name of the object to track. |
| | - **not** — Negates the state of the object. |
| **Step 5** | exit
| Example: | RP/0/RSP0/CPU0:router(config-track-line-prot)# exit |
| Purpose | Exits the track line protocol configuration mode. |
| **Step 6** | delay { up seconds | down seconds }
| Example: | RP/0/RSP0/CPU0:router(config-track)# delay up 10 |
| (Optional) | 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. |
| - Use the **commit** command to save the configuration changes to the running configuration file and remain within the configuration session. |
SUMMARY STEPS

1. configure
2. track track-name
3. type list threshold percentage
4. object object-name
5. threshold percentage up percentage down percentage
6. Use one of the following commands:
   - end
   - commit

DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> configure</td>
<td>Enters track configuration mode.</td>
</tr>
<tr>
<td><strong>Step 2</strong> track track-name</td>
<td>Configures a track of type threshold percentage list.</td>
</tr>
<tr>
<td>Example: RP/0/RSP0/CPU0:router(config)# track track1</td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong> type list threshold percentage</td>
<td>Configures object 1, object 2, object 3 and object 4 as members of track type track1.</td>
</tr>
<tr>
<td>Example: RP/0/RSP0/CPU0:router(config-track-list)# type list threshold percentage</td>
<td></td>
</tr>
<tr>
<td><strong>Step 4</strong> object object-name</td>
<td>Configures the percentage of objects that need to be UP or DOWN for the list to be considered UP or Down respectively.</td>
</tr>
<tr>
<td>Example: RP/0/RSP0/CPU0:router(config-track-list-threshold)# object 1 object 2 object 3 object 4</td>
<td>For example, if object 1, object 2, and object 3 are in the UP state and object 4 is in the DOWN state, the list is considered to be in the UP state.</td>
</tr>
<tr>
<td><strong>Step 5</strong> threshold percentage up percentage down percentage</td>
<td>Saves configuration changes.</td>
</tr>
<tr>
<td>Example: RP/0/RSP0/CPU0:router(config-track-list-threshold)# threshold percentage up 50 down 33</td>
<td></td>
</tr>
<tr>
<td><strong>Step 6</strong> Use one of the following commands:</td>
<td></td>
</tr>
</tbody>
</table>

Example: RP/0/RSP0/CPU0:router(config-track-list-threshold)# threshold percentage up 50 down 33
Purpose

Command or Action | Purpose
--- | ---
• end<br>• commit | • 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.

---

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

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

**SUMMARY STEPS**

1. **configure**
2. **track** *track-name*
3. **type** list threshold weight
4. **object** *object-name* weight weight
5. **threshold** weight up weight down weight
6. Use one of the following commands:
   • **end**
   • **commit**
## DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> configure</td>
<td>Enters track configuration mode.</td>
</tr>
<tr>
<td><strong>Step 2</strong> track <em>track-name</em></td>
<td>* <em>track-name</em>—Specifies a name for the object to be tracked.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>RP/0/RSP0/CPU0:router(config)# track track1</td>
<td>Configures a track of type, threshold weighted list.</td>
</tr>
<tr>
<td><strong>Step 3</strong> type list threshold weight</td>
<td></td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>RP/0/RSP0/CPU0:router(config-track-list)# type list threshold weight</td>
<td>Configures object 1, object 2 and object 3 as members of track t1 and with weights 10, 5 and 3 respectively.</td>
</tr>
<tr>
<td><strong>Step 4</strong> object <em>object-name</em> weight <em>weight</em></td>
<td></td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>RP/0/RSP0/CPU0:router(config-track-list-threshold)# object 1 weight 10</td>
<td>Configures the range of weights for the objects that need to be UP or DOWN for the list to be considered UP or DOWN respectively. In this example, the list is considered to be in the DOWN state because objects 1 and 2 are in the UP state and the cumulative weight is 15 (not in the 10-5 range).</td>
</tr>
<tr>
<td><strong>Step 5</strong> threshold weight up <em>weight</em> down <em>weight</em></td>
<td></td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>RP/0/RSP0/CPU0:router(config-track-list-threshold)# threshold weight up 10 down 5</td>
<td>Saves configuration changes.</td>
</tr>
<tr>
<td><strong>Step 6</strong> Use one of the following commands:</td>
<td>* When you issue the <em>end</em> command, the system prompts you to commit changes:</td>
</tr>
<tr>
<td>• end</td>
<td>Uncommitted changes found, commit them before exiting(yes/no/cancel)? [cancel]:</td>
</tr>
<tr>
<td>• commit</td>
<td>* Entering <em>yes</em> saves configuration changes to the running configuration file, exits the configuration session, and returns the router to EXEC mode.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>RP/0/RSP0/CPU0:router(config-track)# end</td>
<td>* Entering <em>no</em> exits the configuration session and returns the router to EXEC mode without committing the configuration changes.</td>
</tr>
<tr>
<td>or</td>
<td>* Entering <em>cancel</em> leaves the router in the current configuration session without exiting or committing the configuration changes.</td>
</tr>
<tr>
<td>RP/0/RSP0/CPU0:router(config-track)# commit</td>
<td></td>
</tr>
</tbody>
</table>
### Purpose

- 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>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td>configure</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>Example: RP/0/RSP0/CPU0:router# configure</td>
</tr>
<tr>
<td><strong>Step 2</strong></td>
<td><code>track track-name</code></td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>Example: RP/0/RSP0/CPU0:router(config)# track t1</td>
</tr>
<tr>
<td><strong>Step 3</strong></td>
<td><code>type rtr ipsla-no reachability</code></td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>Example: RP/0/RSP0/CPU0:router(config-track)# type rtr 100 reachability</td>
</tr>
<tr>
<td><strong>Step 4</strong></td>
<td><code>commit</code></td>
</tr>
</tbody>
</table>

#### Configuring IPSLA Tracking: Example

This example shows the configuration of IPSLA tracking:

```plaintext
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
```
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>
<tr>
<th>Related Topic</th>
<th>Document Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>IP SLA configuration information</td>
<td>Implementing IP Service Level Agreements on the Cisco ASR 9000 Series Router module in Cisco ASR 9000 Series Aggregation Services Router System Monitoring Configuration Guide</td>
</tr>
<tr>
<td>IP SLA commands</td>
<td>IP Service Level Agreement Commands on the Cisco ASR 9000 Series Router module in Cisco ASR 9000 Series Aggregation Services Router System Monitoring Command Reference</td>
</tr>
<tr>
<td>Related Topic</td>
<td>Document Title</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>-------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Object tracking commands</td>
<td><em>Object Tracking Commands on the Cisco ASR 9000 Series Router module in Cisco ASR 9000 Series Aggregation Services Router System Management Command Reference</em></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 2401</td>
<td><em>Security Architecture for the Internet Protocol</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>
Implementing 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 Cisco ASR 9000 Series Aggregation Services Router IP Addresses and Services Configuration Guide and Cisco ASR 9000 Series Aggregation Services Router IP Addresses and Services Command Reference for more information.

---

**Note**

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 352. 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 35: 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>
</tbody>
</table>

This module contains the following topics:

- Prerequisites for Implementing Physical and Virtual Terminals, page 344
- Information About Implementing Physical and Virtual Terminals, page 344
- How to Implement Physical and Virtual Terminals on Cisco IOS XR Software, page 346
- Craft Panel Interface, page 350
- Configuration Examples for Implementing Physical and Virtual Terminals, page 350
- Additional References, page 352
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 Cisco ASR 9000 Series Aggregation Services Router System Management Command Reference`.

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

**Terminal Identification**

The physical terminal lines for the console port is identified by its location, expressed in the format of `rack/slot/module`, on the active or standby route processor (RP) where the respective console port resides. For virtual terminals, physical location is not applicable; the Cisco IOS XR software assigns a vty identifier to vtyxs 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 vtyxs 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 vtyxs (vtyxs 0 through 4) that each reference the default line template.
- Default fault manager pool—The default fault manager pool consists of six vtyxs (vtyxs 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 vty.
- 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 vty.
- 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>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1 configure</td>
<td></td>
</tr>
<tr>
<td>Step 2 line {console</td>
<td>default}</td>
</tr>
<tr>
<td>Command or Action</td>
<td>Purpose</td>
</tr>
<tr>
<td>------------------</td>
<td>---------</td>
</tr>
</tbody>
</table>

Example:

```console
RP/0/RSP0/CPU0:router(config)# line console
or
RP/0/RSP0/CPU0:router(config)# line default
```

**Step 3**
Configure the terminal attribute settings for the specified template using the commands in line template configuration mode.

**Step 4**
Use one of the following commands:

- `end`
- `commit`

Example:

```console
RP/0/RSP0/CPU0:router(config-line)# end
or
RP/0/RSP0/CPU0:router(config-line)# commit
```

Creating and Modifying vty Pools

This task explains how to create and modify vty pools.

You can omit Step 3, on page 348 to Step 5, on page 348 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`

## 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> `telnet {ipv4</td>
<td>ipv6} server max-servers limit`</td>
</tr>
</tbody>
</table>
| **Example:**  
RP/0/RSP0/CPU0:router(config)# telnet ipv4 server max-servers 10 | |
| **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.  
- If you do not specify a line template with the `line-template` keyword, a vty pool defaults to the default line template.  
- `default` —Configures the default vty pool.  
  - The default vty pool must start at vty 0 and must contain a minimum of five vts (vtys 0 through 4).  
  - You can resize the default vty pool by increasing the range of vts that compose the default vty pool. |
| **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 | |
### Monitoring Terminals and Terminal Sessions

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

**Note**
The commands can be entered in any order.

#### SUMMARY STEPS

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

#### DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong>  `show line [aux location node-id</td>
<td>console location node-id</td>
</tr>
</tbody>
</table>
### Command or Action

<table>
<thead>
<tr>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Specifying the <code>show line aux location node-id</code> EXEC command displays the terminal parameters of the auxiliary line.</td>
</tr>
<tr>
<td>• Specifying the <code>show line console location node-id</code> EXEC command displays the terminal parameters of the console.</td>
</tr>
<tr>
<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>• The <code>node-id</code> argument is expressed in the format of <code>rack/slot/module</code> .</td>
</tr>
<tr>
<td>• Specifying the <code>show line vty number</code> EXEC command displays the terminal parameters for the specified vty.</td>
</tr>
</tbody>
</table>

### Step 2
**show terminal**

(Optimal)
Displays the terminal attribute settings for the current terminal line.

**Example:**

```plaintext
RP/0/RSP0/CPU0:router# show terminal
```

### Step 3
**show users**

(Optimal)
Displays information about the active lines on the router.

**Example:**

```plaintext
RP/0/RSP0/CPU0:router# show users
```

---

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

- The EXEC timeout 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 vty's and to configure the line template test to reference the default vty pool:

```
line template test
  exec-timeout 100 0
  width 100
  length 100
  exit
vty-pool default 0 4 line-template test
```

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

This configuration example shows how to configure a user-defined line template (named test2 in this example) for vty's 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 vty's 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 Cisco ASR 9000 Series Aggregation Services Router System Management Command Reference</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>Related Topic</td>
<td>Document Title</td>
</tr>
<tr>
<td>------------------------------------------------------------------------------</td>
<td>-------------------------------------------------------------------------------</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>Information about user groups and task IDs</td>
<td>Configuring AAA Services on the Cisco ASR 9000 Series Router module of Cisco ASR 9000 Series Aggregation Services Router System Security Configuration 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>
CHAPTER 19

Implementing SNMP

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 380. 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 36: 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</td>
</tr>
<tr>
<td></td>
<td>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, page 356
- Restrictions for SNMP Use on Cisco IOS XR Software, page 356
- Information About Implementing SNMP, page 356
- Session MIB support on subscriber sessions, page 363
- How to Implement SNMP on Cisco IOS XR Software, page 365
- Configuration Examples for Implementing SNMP, page 375
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.

Figure 8: Communication Between an SNMP Agent and Manager, on page 357 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 8: Communication Between an SNMP Agent and Manager

Related Topics

Additional References, on page 380

SNMP Notifications

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

Note

Inform requests (inform operations) are supported in Cisco IOS XR software from release 4.1 onwards. For more information, see http://www.cisco.com/c/en/us/td/docs/routers/asr9000/software/asr9k_r5-3/sysman/command/reference/b-sysman-cr53xasr/b-sysman-cr53xasr_chapter_010010.html#wp2863682680

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.

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 9: Trap Received by the SNMP Manager**

```
SNMP agent ----> Trap ----> 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.

**Figure 10: Trap Not Received by the SNMP Manager**

```
SNMP agent ----> 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 38: SNMP Security Models and Levels, on page 360 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.

Table 37: SNMPv1, v2c, and v3 Feature Support, on page 359 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. Table 38: SNMP Security Models and Levels, on page 360 identifies what the combinations of security models and levels mean.

Table 38: SNMP Security Models and Levels

<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>
<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.</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.

#### What Happens

<table>
<thead>
<tr>
<th>Model</th>
<th>Level</th>
<th>Authentication</th>
<th>Encryption</th>
<th>What Happens</th>
</tr>
</thead>
<tbody>
<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>

---

**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*.”**

---

4 Hash-Based Message Authentication Code  
5 Message Digest 5  
6 Secure Hash Algorithm  
7 Data Encryption Standard  
8 Cipher Block Chaining  
9 Triple Data Encryption Standard  
10 Advanced Encryption Standard
Message stream modification — The threat that messages may be maliciously reordered, delayed, or replayed (to an extent that is greater than can occur through the natural operation of a subnetwork service) to cause SNMP to perform unauthorized management operations.

Disclosure — The threat that exchanges between SNMP engines could be eavesdropped. Protecting against this threat may be required as a matter of local policy.

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

### SNMPv3 Costs

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

Table 39: Order of Response Times from Least to Greatest, on page 362 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.

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 11: Trap 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.

**Figure 12: Trap Not Received by the SNMP Manager**

### Session Types

The supported session types are:

- PPPoE
- IP SUB PKT
- IP SUB DHCP

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

This section describes how to implement SNMP. The `snmp-server` commands enable SNMP on Management Ethernet interfaces by default. For information on how to enable SNMP server support on other inband interfaces, see the Implementing Management Plane Protection on Cisco IOS XR Software module in Cisco ASR 9000 Series Aggregation Services Router System Security Configuration Guide.

### Configuring SNMPv3

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

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

1. configure
2. 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> configure</td>
<td></td>
</tr>
<tr>
<td><strong>Step 2</strong> snmp-server view view-name oid-tree {included</td>
<td>excluded}</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>RP/0/RSP0/CPU0:router(config)# snmp-server view view_name 1.3.6.1.2.1.1.5 included</td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong> snmp-server group name {v1</td>
<td>v2c</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>RP/0/RSP0/CPU0:router(config)# snmp-server group group_name v3 noauth read view_name1 write view_name2</td>
<td></td>
</tr>
<tr>
<td><strong>Step 4</strong> snmp-server user username groupname {v1</td>
<td>v2c</td>
</tr>
<tr>
<td>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.</td>
<td></td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>RP/0/RSP0/CPU0:router(config)# snmp-server user noauth user group_name v3</td>
<td></td>
</tr>
<tr>
<td><strong>Step 5</strong> commit</td>
<td></td>
</tr>
</tbody>
</table>

Configuring SNMP Trap Notifications

This task explains how to configure the router to send SNMP trap notifications.
You can omit Step 3, on page 366 if you have already completed the steps documented under the Configuring SNMPv3, on page 365 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

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

**Example:**

```bash
RP/0/RSP0/CPU0:router(config)# snmp-server group group_name v3 noauth read view_name1 write view_name2
```

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

| **Step 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]`

**Example:**

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

Configures a new user to an SNMP group.

**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.
## Purpose Command or Action

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</thead>
<tbody>
<tr>
<td></td>
<td>`snmp-server host address [traps] [version 1</td>
<td>2c</td>
</tr>
</tbody>
</table>

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

<table>
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<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><code>snmp-server traps [notification-type]</code></td>
<td>Enables the sending of trap notifications and specifies the type of trap notifications to be sent.</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Step 6</th>
<th>Command Format</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><code>commit</code></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Step 7</th>
<th>Command Format</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><code>show snmp host</code></td>
<td>(Optional) Displays information about the configured SNMP notification recipient (host), port number, and security model.</td>
</tr>
</tbody>
</table>

**Example:**
```
RP/0/RSP0/CPU0:router# show snmp host
```

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

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

**Note**

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

### SUMMARY STEPS

1. `configure`
2. (Optional) `snmp-server contact system-contact-string`
3. (Optional) `snmp-server location system-location`
4. (Optional) `snmp-server chassis-id serial-number`
5. `commit`
### DETAILED STEPS

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

### Example:

```
RP/0/RSP0/CPU0:router(config)# snmp-server packetsize 1024
```
### 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>
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</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>
</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>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1</td>
<td><code>snmp-server entityindex persist</code></td>
<td>(Optional) Enables the persistent storage of ENTITY-MIB data.</td>
</tr>
</tbody>
</table>
### Implementing SNMP

#### 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

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</thead>
<tbody>
<tr>
<td></td>
<td>configure</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Step 2</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>snmp-server interface subset subset-number regular-expression expression</td>
<td>Enters snmp-server interface mode for the interfaces identified by the regular expression. The subset-number argument identifies the set of interfaces, and also assigns a priority to the subset in the event that an interface is included in more than one subset. Lower numbers have higher priority and their configuration takes precedent over interface subsets with higher numbers.</td>
</tr>
<tr>
<td></td>
<td>Example: RP/0/RSP0/CPU0:router(config)# snmp-server interface subset 10 regular-expression &quot;^Gig[a-zA-Z]+[0-9/]+.&quot;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>RP/0/RSP0/CPU0:router(config-snmp-if-subset)#</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Step 3</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>notification linkupdown disable</td>
<td>Disables linkUp and linkDown traps for all interfaces being configured. To enable previously disabled interfaces, use the no form of this command.</td>
</tr>
<tr>
<td></td>
<td>Example: RP/0/RSP0/CPU0:router(config-snmp-if-subset)# notification linkupdown disable</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Step 4</th>
<th>Command or Action</th>
<th>Purpose</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>commit</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Step 5</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>show snmp interface notification subset subset-number</td>
<td>(Optional) Displays the linkUp and linkDown notification status for all interfaces identified by the subset priority.</td>
</tr>
<tr>
<td></td>
<td>Example: RP/0/RSP0/CPU0:router# show snmp interface notification subset 10</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Step 6</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>show snmp interface notification regular-expression expression</td>
<td>(Optional) Displays the linkUp and linkDown notification status for all interfaces identified by the regular expression.</td>
</tr>
<tr>
<td></td>
<td>Example: RP/0/RSP0/CPU0:router# show snmp interface notification regular-expression &quot;^Gig[a-zA-Z]+[0-9/]+.&quot;</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Step 7</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>show snmp interface notification type interface-path-id</td>
<td>(Optional) Displays the linkUp and linkDown notification status for the specified interface.</td>
</tr>
<tr>
<td></td>
<td>Example: RP/0/RSP0/CPU0:router# show snmp interface notification tengige 0/4/0/3.10</td>
<td></td>
</tr>
</tbody>
</table>
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:

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

Note

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

Verifying the Identification of the Local SNMP Engines

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

```
config
show snmp engineid
SNMP engineID 00000009000000a1ffffffff
```

Creating a View

There are two ways to create a view:

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

- You can exclude the OID subtree of the ASN.1 subtree of a MIB family from a view by using the excluded keyword of the `snmp-server view` command.

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

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

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

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

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

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

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

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
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:

```
snmp-server user username nervectrgrp remote 10.69.236.146 udp-port 162 v3 auth sha <password> 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>
```

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

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

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

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

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

```
SNMP server user batmanusr1 nervectrgrp remote 10.69.236.146 udp-port 162 v3 auth sha encrypted <password> priv aes 128 encrypted <password>
SNMP server user batmanusr2 nervectrgrp remote 10.214.127.2 udp-port 162 v3 auth sha encrypted <password> priv aes 128 encrypted <password>
SNMP server user batmanusr3 nervectrgrp remote 10.69.236.146 udp-port 162 v3 auth sha encrypted <password> priv aes 128 encrypted <password>
```

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
```

**Note**

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

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

```
RP/0/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
```

**Note**

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

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

```
RP/0/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.

```
! 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 host 10.50.32.170 version 3 noauth userV3noauth udp-port 2345
snmp-server user userv2c groupv2c v2c
snmp-server user userV3auth groupV3auth v3 auth md5 encrypted 140F0A13
snmp-server user userV3priv groupV3priv v3 auth md5 encrypted 021E1C43 priv des56 encrypted 1110001C
snmp-server user userV3noauth groupV3noauth v3 LROwner
snmp-server 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
snmp-server ipv4 precedence 7
exit
Uncommitted changes found, commit them before exiting(yes/no/cancel)? [cancel]: y
```

Setting an IP DSCP Value for SNMP Traffic: Example

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

```
configure
snmp-server ipv4 dscp 45
exit
Uncommitted changes found, commit them before exiting(yes/no/cancel)? [cancel]: y
```

Additional References

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

**Related Documents**

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<td>SNMP Server Commands on the Cisco ASR 9000 Series Router module of Cisco ASR 9000 Series Aggregation Services Router System Management Command Reference</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 Cisco ASR 9000 Series Aggregation Services Router System Security Configuration Guide</td>
</tr>
<tr>
<td>Cisco IOS XR Quality of Service</td>
<td>Cisco ASR 9000 Series Aggregation Services Router Modular Quality of Service Configuration 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>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>
</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 20

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 40: 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, page 383
- Information About Periodic MIB Data Collection and Transfer, page 384
- 4arg, page 385
- How to Configure Periodic MIB Data Collection and Transfer, page 385
- Periodic MIB Data Collection and Transfer: Example, page 392

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 : (FID=12345) : -Traceback= 4bd43404 4bac7e04 4000c100
```

**Note**

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.
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> <code>snmp-server mib bulkstat object-list list-name</code></td>
<td>Defines an SNMP bulk statistics object list and enters bulk statistics object list configuration mode.</td>
</tr>
<tr>
<td><strong>Example:</strong> <code>snmp-server mib bulkstat object-list ifMib</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong> `add {oid</td>
<td>object-name}`</td>
</tr>
<tr>
<td><strong>Example:</strong> RP/0/RSP0/CPU0:router(config-bulk-objects)# add 1.3.6.1.2.1.2.2.1.11 RP/0/RSP0/CPU0:router(config-bulk-objects)# add ifAdminStatus RP/0/RSP0/CPU0:router(config-bulk-objects)# add ifDescr</td>
<td></td>
</tr>
<tr>
<td><strong>Step 4</strong> commit</td>
<td></td>
</tr>
</tbody>
</table>

**What to Do Next**

Configure a bulk statistics schema.

**Configuring a Bulk Statistics Schema**

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

**Before You Begin**

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

1. `configure`
2. `snmp-server mib bulkstat schema schema-name`
3. `object-list list-name`
4. Do one of the following:
   - `instance exact {interface interface-id [sub-if] | oid oid}
   - `instance wild {interface interface-id [sub-if] | oid oid}
   - `instance range start oid end oid
   - `instance repetition oid max repeat-number`
5. `poll-interval minutes`
6. `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 schema schema-name</code></td>
<td>Names the bulk statistics schema and enters bulk statistics schema mode.</td>
</tr>
<tr>
<td>Example: <code>snmp-server mib bulkstat schema intE0</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong> <code>object-list list-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>Example: <code>object-list ifMib</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 4</strong> Do one of the following:</td>
<td>Specifies the instance information for objects in this schema:</td>
</tr>
<tr>
<td>- `instance exact {interface interface-id [sub-if]</td>
<td>oid oid}`</td>
</tr>
<tr>
<td>- `instance wild {interface interface-id [sub-if]</td>
<td>oid oid}`</td>
</tr>
<tr>
<td>- <code>instance range start oid end oid</code></td>
<td>- The <code>instance range</code> command indicates a range of instances on which to collect data.</td>
</tr>
<tr>
<td>- <code>instance repetition oid max repeat-number</code></td>
<td></td>
</tr>
</tbody>
</table>
### 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.

---

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Example:</strong> RP/0/RSP0/CPU0:router(config-bulk-sc)# instance wild oid 1 or RP/0/RSP0/CPU0:router(config-bulk-sc)# instance exact interface FastEthernet 0/1.25 or RP/0/RSP0/CPU0:router(config-bulk-sc)# instance range start 1 end 2 or RP/0/RSP0/CPU0:router(config-bulk-sc)# instance repetition 1 max 4</td>
<td>• The <strong>instance repetition</strong> command indicates data collection to repeat for a certain number of instances of a MIB object. <strong>Note</strong> Only one <strong>instance</strong> command can be configured per schema. If multiple <strong>instance</strong> commands are executed, the earlier ones are overwritten by new commands.</td>
</tr>
<tr>
<td><strong>Step 5</strong></td>
<td><strong>poll-interval minutes</strong></td>
</tr>
<tr>
<td><strong>Example:</strong> RP/0/RSP0/CPU0:router(config-bulk-sc)# poll-interval 10</td>
<td>Sets how often data should be collected from the object instances specified in this schema, in minutes. The default is once every 5 minutes. The valid range is from 1 to 20000.</td>
</tr>
<tr>
<td><strong>Step 6</strong></td>
<td><strong>commit</strong></td>
</tr>
</tbody>
</table>

### What to Do Next

Configure 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>
<tr>
<td><strong>Example:</strong> RP/0/RSP0/CPU0:router(config)# snmp-server mib bulkstat transfer bulkstat1</td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong> <code>buffer-size</code> <code>bytes</code></td>
<td>(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.</td>
</tr>
<tr>
<td><strong>Example:</strong> RP/0/RSP0/CPU0:router(config-bulk-tr)# buffersize 3072</td>
<td><strong>Note</strong> 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.</td>
</tr>
<tr>
<td><strong>Step 4</strong> `format {bulkBinary</td>
<td>bulkASCII</td>
</tr>
<tr>
<td><strong>Example:</strong> RP/0/RSP0/CPU0:router(config-bulk-tr)# format schemaASCII</td>
<td><strong>Note</strong> Transfers can only be performed using schemaASCII (ccdSchemaASCII) format. SchemaASCII is a human-readable format that contains parser-friendly hints for parsing data values.</td>
</tr>
</tbody>
</table>
### Configuring Bulk Statistics Transfer Options

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 5</strong></td>
<td>Specify 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).</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>RP/0/RSP0/CPU0:router(config-bulk-tr)# schema ATM2/0-IFMIB RP/0/RSP0/CPU0:router(config-bulk-tr)# schema Ethernet2/1-IFMIB</td>
</tr>
<tr>
<td><strong>Step 6</strong></td>
<td>(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.</td>
</tr>
<tr>
<td><strong>transfer-interval minutes</strong></td>
<td>RP/0/RSP0/CPU0:router(config-bulk-tr)# transfer-interval 20</td>
</tr>
<tr>
<td><strong>Step 7</strong></td>
<td>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.</td>
</tr>
<tr>
<td><strong>url primary url</strong></td>
<td>RP/0/RSP0/CPU0:router(config-bulk-tr)# url primary ftp://user:password@host/folder/bulkstat1</td>
</tr>
<tr>
<td><strong>Step 8</strong></td>
<td>(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.</td>
</tr>
<tr>
<td><strong>url secondary url</strong></td>
<td>RP/0/RSP0/CPU0:router(config-bulk-tr)# url secondary tftp://10.1.0.1/tftpboot/user/bulkstat1</td>
</tr>
<tr>
<td><strong>Step 9</strong></td>
<td>(Optional) Specifies the number of transmission retries. The default value is 0 (in other words, no retries). If an attempt to send the bulk statistics file fails, the system can be configured to attempt to send the file again using this command. One retry includes an attempt first to the primary destination then, if the transmission fails, to the secondary location. For example, if the retry value is 1, an attempt is made first to the primary URL, then to the secondary URL, then to the primary URL again, then to the secondary URL again. The valid range is from 0 to 100. If all retries fail, the next normal transfer occurs after the configured transfer-interval time.</td>
</tr>
<tr>
<td><strong>retry number</strong></td>
<td>RP/0/RSP0/CPU0:router(config-bulk-tr)# retry 1</td>
</tr>
<tr>
<td><strong>Step 10</strong></td>
<td>(Optional) Specifies how long the bulk statistics file should be kept in system memory, in minutes, after the completion of the collection interval and a transmission attempt is made. The default value is 0. Zero (0) indicates that the file is deleted immediately after the transfer is attempted. The valid range is from 0 to 20000.</td>
</tr>
<tr>
<td><strong>retain minutes</strong></td>
<td>RP/0/RSP0/CPU0:router(config-bulk-tr)# retain 60</td>
</tr>
</tbody>
</table>
### Configuring Periodic MIB Data Collection and Transfer

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Note</strong></td>
<td>If the retry command is used, you should configure a retain interval larger than 0. The interval between retries is the retain interval divided by the retry number. For example, if <code>retain 10</code> and <code>retry 2</code> are configured, two retries are attempted once every 5 minutes. Therefore, if retain 0 is configured, no retries are attempted.</td>
</tr>
</tbody>
</table>

**Step 11** `enable`

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

**Step 12** `commit`

---

**What to Do Next**

**Note**

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

**Purpose**

Command or Action | Purpose
--- | ---
(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.)

**Step 1**

```
show snmp mib bulkstat transfer
```

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.

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)
```

### Periodic MIB Data Collection and Transfer: Example

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

```
snmp-server mib bulkstat object-list cempo
add cempMemPoolName
add cempMemPoolType

snmp-server mib bulkstat schema cempWild
object-list cempo
instance wild oid 8695772
poll-interval 1

snmp-server mib bulkstat schema cempRepeat
object-list cempo
instance repetition 8695772.1 max 4294967295
poll-interval 1

snmp-server mib bulkstat transfer-id cempt1 enable
```
schema cempWild
schema cempRepeat
transfer-interval 2
!

This example shows sample bulk statistics file content:

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

Schema-def cempt1.cempRepeat "%u, %s, %s, %d" Epochtime instanceoid
1.3.6.1.4.1.9.9.221.1.1.1.1.3 1.3.6.1.4.1.9.9.221.1.1.1.1.2
  cempt1.cempRepeat: 1339491515, 8695772.1, processor, 2
  cempt1.cempRepeat: 1339491515, 8695772.2, reserved, 11
  cempt1.cempRepeat: 1339491515, 8695772.3, image, 12
  cempt1.cempRepeat: 1339491515, 26932192.1, processor, 2
  cempt1.cempRepeat: 1339491515, 26932192.2, reserved, 11
  cempt1.cempRepeat: 1339491515, 26932192.3, image, 12
  cempt1.cempRepeat: 1339491515, 35271015.1, processor, 2
  cempt1.cempRepeat: 1339491515, 35271015.2, reserved, 11
  cempt1.cempRepeat: 1339491515, 35271015.3, image, 12
  cempt1.cempRepeat: 1339491515, 52690955.1, processor, 2
  cempt1.cempRepeat: 1339491515, 52690955.2, reserved, 11
  cempt1.cempRepeat: 1339491515, 52690955.3, image, 12
```
Periodic MIB Data Collection and Transfer: Example
Implementing CDP

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 402. 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 41: 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>
</tbody>
</table>

This module contains the following topics:

- Prerequisites for Implementing CDP, page 395
- Information About Implementing CDP, page 396
- How to Implement CDP on Cisco IOS XR Software, page 397
- Configuration Examples for Implementing CDP, page 402
- Additional References, page 402

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 42: Type-Length-Value Definitions for CDPv2, on page 396 summarizes the TLV definitions for CDP advertisements.

<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>
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>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>cdp</td>
<td>Enables CDP globally.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>RP/O/RSP0/CPU0:router(config)# cdp</td>
<td></td>
</tr>
<tr>
<td>Step 3</td>
<td>interface type interface-path-id</td>
<td>Enters interface configuration mode.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>RP/O/RSP0/CPU0:router(config)# interface pos 0/0/0/1</td>
<td></td>
</tr>
</tbody>
</table>
### 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>
<tr>
<td>Step 2 cdp advertise v1</td>
<td>Configures CDP to use only version 1 (CDPv1) in communicating with neighboring devices.</td>
</tr>
</tbody>
</table>

  - 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.

---

**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.
<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 3</strong></td>
<td><strong>cdp holdtime seconds</strong></td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td><strong>RP/0/RSP0/CPU0:router(config)# cdp holdtime 30</strong></td>
</tr>
<tr>
<td></td>
<td>Specifies the amount of time that the receiving networking device will hold a CDP packet sent from the router before discarding it.</td>
</tr>
<tr>
<td></td>
<td>• By default, when CDP is enabled, the receiving networking device holds a CDP packet for 180 seconds before discarding it.</td>
</tr>
<tr>
<td></td>
<td>• Note The CDP hold time must be set to a higher number of seconds than the time between CDP transmissions, which is set with the cdp timer command.</td>
</tr>
<tr>
<td></td>
<td>• In this example, the value of hold-time for the seconds argument is set to 30.</td>
</tr>
<tr>
<td><strong>Step 4</strong></td>
<td><strong>cdp timer seconds</strong></td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td><strong>RP/0/RSP0/CPU0:router(config)# cdp timer 20</strong></td>
</tr>
<tr>
<td></td>
<td>Specifies the frequency at which CDP update packets are sent.</td>
</tr>
<tr>
<td></td>
<td>• By default, when CDP is enabled, CDP update packets are sent at a frequency of once every 60 seconds.</td>
</tr>
<tr>
<td></td>
<td>• Note A lower timer setting causes CDP updates to be sent more frequently.</td>
</tr>
<tr>
<td></td>
<td>• In this example, CDP update packets are configured to be sent at a frequency of once every 20 seconds.</td>
</tr>
<tr>
<td><strong>Step 5</strong></td>
<td><strong>commit</strong></td>
</tr>
<tr>
<td><strong>Step 6</strong></td>
<td><strong>show cdp</strong></td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td><strong>RP/0/RSP0/CPU0:router# show cdp</strong></td>
</tr>
<tr>
<td></td>
<td>(Optional)</td>
</tr>
<tr>
<td></td>
<td>Displays global CDP information.</td>
</tr>
<tr>
<td></td>
<td>The output displays the CDP version running on the router, the hold time setting, and the timer setting.</td>
</tr>
</tbody>
</table>

**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>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td>**show cdp entry [*</td>
</tr>
<tr>
<td><strong>Example:</strong> RP/0/RSP0/CP00:router# show cdp entry *</td>
<td></td>
</tr>
<tr>
<td><strong>Step 2</strong></td>
<td>**show cdp interface [type interface-path-id</td>
</tr>
<tr>
<td><strong>Example:</strong> RP/0/RSP0/CP00:router# show cdp interface pos 0/0/0/1</td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong></td>
<td>**show cdp neighbors [type interface-path-id</td>
</tr>
<tr>
<td><strong>Example:</strong> RP/0/RSP0/CP00:router# show cdp neighbors</td>
<td></td>
</tr>
<tr>
<td><strong>Step 4</strong></td>
<td><strong>show cdp traffic [location node-id]</strong> Displays information about the traffic gathered between devices using CDP.</td>
</tr>
<tr>
<td><strong>Example:</strong> RP/0/RSP0/CP00:router# show cdp traffic</td>
<td></td>
</tr>
</tbody>
</table>

Examples

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

```
RP/0/RSP0/CP00: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 Holdtime Capability Platform Port ID
router1 Mg0/0/CP00/0 177 T S WS-C2924M Fa0/12
router2 P00/4/0/1 157 R 12008/GRP P00/4/0/1
```

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/CP00: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
IPv6 address: 1::1
IPv6 address: 2::2
```
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 entry** command. In this example, the optional *entry* argument is used to display entry information related to a specific CDP neighbor.

RP/0/RSP0/CP00: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/CP00: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/CP00: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 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/CP00:router# show cdp traffic location 0/4/cpu0

CDP counters :
Packets output: 16, Input: 13
Hdr syntax: 0, Chksum error: 0, Encaps failed: 0
No memory: 0, Invalid packet: 0, Truncated: 0
CDP version 2 advertisements output: 0, Input: 0
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:

```
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:

```
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><em>CDP Commands on Cisco IOS XR Software</em> module of <em>Cisco ASR 9000 Series Aggregation Services Router System Management Command Reference</em></td>
</tr>
<tr>
<td>Cisco IOS XR commands</td>
<td><em>Cisco ASR 9000 Series Aggregation Services Router Commands Master List</em></td>
</tr>
<tr>
<td>Getting started with Cisco IOS XR Software</td>
<td><em>Cisco ASR 9000 Series Aggregation Services Router Getting Started Guide</em></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>