System Management Configuration Guide for the Cisco NCS 6000 Series Router, Release 5.0.x

First Published: 2013-09-01

Last Modified: 2014-01-01

Americas Headquarters
Cisco Systems, Inc.
170 West Tasman Drive
San Jose, CA 95134-1706
USA
http://www.cisco.com
Tel: 408 526-4000
800 553-NETS (6387)
Fax: 408 527-0883

CONTENTS

Preface

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

Changes to this Document

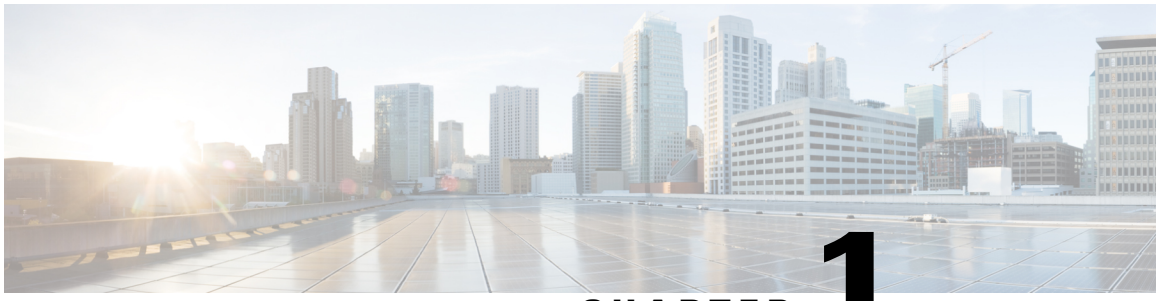
Table 1: For NCS 6000 Series Router

Revision	Date	Summary
OL-30990-01	November 2013	Initial release of this document.

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.



CHAPTER 1

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 FPGAs. Cisco IOS XR software provides the Cisco FPD upgrade feature to manage the upgrade of FPD images .

For complete descriptions of the FPD commands listed in this module, see Related Documents, on page 5. .

Table 2: Feature History for Upgrading FPD Software on Cisco IOS XR Software

Release	Modification
Release 5.0.0	This feature was introduced.
Release 6.4.1	Support for parallel FPD upgrade for power modules.

This module contains the following topics:

FPD

An FPD is a field programmable logic device which contains non-volatile, re-programmable memory to define its internal wiring and functionality. The contents of this non-volatile memory are called the FPD image or FPD firmware. Over the lifespan of an FPD, FPD firmware images may need upgrades for bug fixes or functionality improvements. These upgrades are performed in the field with minimum system impact.

Prerequisites for FPD Image Upgrades

Before upgrading the FPD on your router you must install and activate the fpd.rpm package.

This is for the manual upgrade using the **upgrade hw-module FPD** command.

Overview of FPD Image Upgrade Support

An FPD image is used to upgrade the software on an FPD.

FPD versions must be compatible with the Cisco IOS XR software that is running on the router; if an incompatibility exists between an FPD version and the Cisco IOS XR software, the device with the FPGA may not operate properly until the incompatibility is resolved.

Related Topics

show hw-module fpd Command Output: Example

Automatic FPD Upgrade

FPD auto-upgrade can be enabled and disabled. When auto FPD is enabled, it automatically updates FPDs when a SMU or image changes, including an updated firmware revision. Use the **fpd auto-upgrade** command to disable or enable auto-fpd.

FPD upgrade service

The main tasks of the FPD upgrade service are:

- FPD image version checking to decide if a specific firmware image needs an upgrade or not.
- Automatic FPD Image Upgrade (if enabled).
- Manual FPD Image Upgrade using the **upgrade hw-module fpd** command.
- Invoke the appropriate device driver with a name of the new image to load.

An FPD image package is used to upgrade FPD images. The **install activate** command is used to place the FPD binary files into the expected location on the boot devices.

Supported Upgrade Methods

Method	Remarks
Manual Upgrade	Upgrade using CLI, force upgrade supported.
Auto Upgrade	Upgrade using install SMU activation or during image upgrade. User can enable/disable auto upgrade feature.

Determining Upgrade Requirement

Use the **show hw-module fpd** command to determine if an FPD upgrade is required. Check for NEED UPGD in the Status column.

Use the **show fpd package** command to find out which FPGAs are supported with your current software release and minimum hardware requirements for each module.

Automatic FPD upgrade

Use the **fpd auto-upgrade enable** command to enable the auto upgrade feature.

The FPD images are upgraded as part of the install activation of the new image. The FPDs are upgraded before the router is reloaded.

During an FPD auto-upgrade, the installed FPD rpm package includes an FPD image with a new version of software that is different than the version of the image running on the hardware. Once the FPDs have been upgraded, even if the base image is rolled backed to the older version, the FPD will not be downgraded to its previous version.

When a reload package is installed with new FPD images, the FPD images are upgraded before the router gets reloaded. This feature is controlled through an fpd auto-upgrade configuration option. The auto-upgrade feature does not address the following:

- FPD Upgrade during initial boot
- FPD Upgrade during new card insertion

Manual FPD upgrade

Manual FPD upgrade is performed using the **upgrade hw-module fpd** command. All cards or all of FPGA in a card can be upgraded. If reload is required to activate FPD , the upgrade should be complete. All line-cards, fabric cards and RP cards cannot be reloaded during the process of the FPD upgrade.

FPD upgrade is transaction-based:

- Each fpd upgrade cli execution is one transaction
- Only one transaction is allowed at any given time
- One transaction may include one or many FPD upgrade(s)

The **force** option can be used to forcibly upgrade the FPD (regardless of whether it is required or not). It triggers all FPDs to be upgraded or downgraded. The force option can also be used to downgrade or upgrade the FPGAs even after the version check.

Note In some cases, FPDs can have primary and backup images.

FPD upgrade

The key to understanding the FPD output is that nodes can have two firmware versions. One, which is currently running, and a downloaded version, which will become the running version after the next boot. The running version and downloaded version can be the same. There are circumstances where this is not the case, and that would be if a node was recently upgraded, and requires a reboot to load the new updated package. Generally, the downloaded version is the latest version, when compared to the running version. FPD packages that do not require a reload to activate the new firmware version would not see the version skew. Below is a sample output showing version skew on the CCC FPGA. After reload, both running and downloaded versions will be the same. CCC Power-On is in need of an upgrade. To see what version is expected, issue the command **show fpd package** and find the FPD device for that card type which is in need of upgrade.

```
show hw-module fpd
                                                                          FPD Versions
                                                                         ================
Location      Card type     HWver   FPD device       Status    Running Download
-------------------------------------------------------------------------------------
0/0           NC6-10X100G-L 0.6     CCC FPGA         UPGD DONE   1.13    1.14
0/0           NC6-10X100G-L 0.6     BAO-MB FPGA      READY       1.00    1.00
0/0           NC6-10X100G-L 0.6     CCC Power-On     NEED UPGD   1.28    1.28
0/0           NC6-10X100G-L 0.6     Ethernet Switch  READY       1.32    1.32
0/0           NC6-10X100G-L 0.6     BIOS FPD         READY       9.10    9.10
0/0           NC6-10X100G-L 1.0     Slice-0 GN2411   READY       2.07    2.07
0/0           NC6-10X100G-L 1.0     Slice-1 GN2411   READY       2.07    2.07
0/0           NC6-10X100G-L 0.6     BAO-DB FPGA      READY       1.00    1.00
0/0           NC6-10X100G-L 1.0     S2 GN2411        READY       2.07    2.07
0/0           NC6-10X100G-L 1.0     S3 GN2411        READY       2.07    2.07
0/0           NC6-10X100G-L 1.0     S4 GN2411        READY       2.07    2.07
show fpd package
Mon Oct  7  18:08:21.994 UTC

================================ ================================================
                                        Field Programmable Device Package
                                 ================================================
                                                  Req     SW      Min Req   Min Req
Card Type            FPD Description              Reload  Ver     SW Ver  Board Ver
==================== ============================ ======= ======= ======== =========
P-L-1xPAT_SFP        BAO-MB FPGA                   NO      0.20      0.20      0.0
                     CCC FPGA                      YES     1.14      1.14      0.0
                     CCC Power-On                  YES     1.30      1.30      0.0
                     Ethernet Switch               YES     1.32      1.32      0.0
                     BIOS FPD                      YES     9.10      9.10      0.0
                     SB Certificates               NO      1.00      1.00      0.0
```

To upgrade an fpd device, such as the one above, use the **upgrade hw-module location 0/0 fpd CCC\ Power-On** command or if it is more desirable to upgrade all components that need upgrading at the same time, use the **upgrade hw-module location all fpd all** command. Note that this upgrade will require a reload of the node to take effect. Adding the force option will upgrade all FPD devices regardless if they require upgrading or not. This is not recommended.

The command used for upgrade is: **upgrade hw-module location** *location of node* **fpd** *fpd device*

The **show fpd package** command displays 4 very critical pieces of information with regard to firmware that is imbedded in the current running XR image. The first column displays whether a reload would be required to make the updated FPD version the running version. The second column shows the version number of firmware residing on the running XR image. The forth and fifth columns show, based on the current running XR image, what the minimum requirements are for both firmware and hardware versions for each programmable device.

Additional References

The following sections provide references related to FPD software upgrade.

Related Documents

Related Topic	Document Title
Cisco IOS XR command master list	
Cisco IOS XR FPD upgrade-related commands	*System Management Command Reference for Cisco NCS 6000 Series Routers*
Initial system bootup and configuration information for a router using the Cisco IOS XR Software.	
Information about user groups and task IDs	*Configuring AAA Services on* module of *System Security Configuration Guide for Cisco NCS 6000 Series Routers*

Standards

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

MIBs

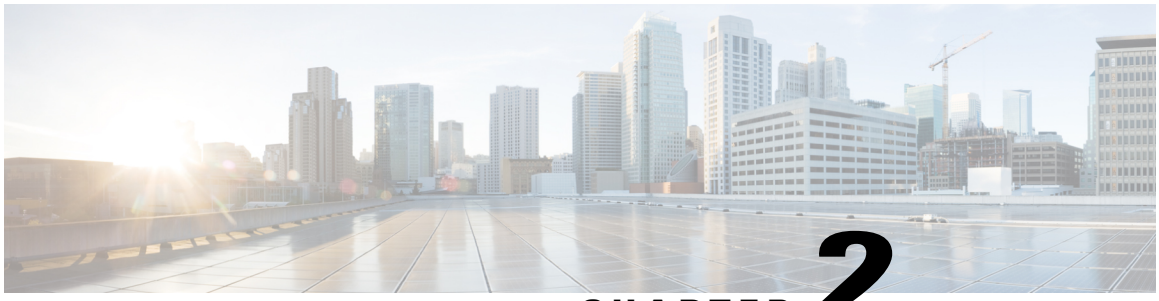
MIBs	MIBs Link
There are no applicable MIBs for this module.	To locate and download MIBs for selected platforms using Cisco IOS XR Software, use the Cisco MIB Locator found at the following URL: http://cisco.com/public/sw-center/netmgmt/cmtk/mibs.shtml

RFCs

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

Technical Assistance

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



CHAPTER 2

Process Placement

This module describes conceptual information and configuration tasks for process placement on your router.

Process Placement on Cisco IOS XR software balances application processes between the available based on memory usage and other criteria. Use the procedures described in this document to reoptimize the placement of processes, or override the default placement policies.

For complete descriptions of the process placement commands listed in this module, see Related Documents, on page 21. .

Table 3: Feature History for Configuring Cisco IOS XR Process Placement

Release	Modification
Release 5.0.0	This feature was introduced.

This module contains the following topics:

Prerequisites for Configuring Cisco IOS XR Process Placement

Note Only processes that are identified in Cisco IOS XR software as placeable can be controlled through process placement configuration. Nonplaceable processes are not affected by placement policy. To learn the processes that are placeable, issue the **show placement program all** command.

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 Cisco IOS XR Process Placement

What Is a Process?

To achieve high availability and performance, the Cisco IOS XR software is built on a modular system of processes. Each process provides specific functionality for the system and runs in a protected memory space to ensure that problems with one process cannot impact the entire system. Multiple instances of a process can run on a single node, and multiple threads of execution can run on each process instance.

Under normal operating conditions, processes are managed automatically by the Cisco IOS XR software. Processes are started, stopped, or restarted as required by the running configuration of the router. In addition, processes are checkpointed to optimize performance during process restart and automatic switchover.

What Is Process Placement?

Process placement is the assignment of placeable processes to specific locations, such as an installed in the router.

Placeable processes include all routing processes, such as Open Shortest Path First Protocol (OSPF), Border Gateway Protocol (BGP), and multicast routing.

Default Placement Policy

In a new system, processes are distributed according to their affinity values among the available nodes and node pairs in a .

Note The default process policy that is shipped on the system upon startup is suitable for general purposes. While customizing is possible, there is no requirement to change the process placement. If you believe the a change is required, you should work closely with Cisco personnel to ensure that the impact to your system is contained to just an instance of a process to avoid any undesirable results.

Following is the default placement policy:

- Processes have a preference to run on paired nodes (nodes that have an associated standby node).
- Processes have a preference to remain on their current node. Therefore, processes do not move automatically, unless the unpaired node (or both nodes in a node pair) on which they are running fails. If the node fails, and there is no standby node, the processes are restarted on a different node.
- When a new node pair is added, the following rules apply:
    - The currently running processes are not automatically moved to the new cards.

- The general preference is for new processes (such as a new ISIS instance) to start on the new node pair, which contains the most available CPU and memory resources in the system.
- Other affinity settings may override the general preference. For example, if the IS-IS process has a strong affinity to run on the same node where ipv4_io is running, then IS-IS would be started on that node, and not the new node-pair.

Reasons to Change the Default Process Placement

Although the default process policy that is shipped on the system upon startup is suitable for general purposes, changes to the router configuration can result in the need for processes to be rebalanced among the available CPU and memory resources.

When a system is initially booted, the system assumes that all processes use the same amount of memory, thereby treating each process as equivalent. As the configuration grows, however, the CPU load and memory requirements of some application processes increase. Centralized applications may need a larger portion of the resources.

In addition, when a new is added to a system, only new processes or process instances are added to the node. This could result in some processes with too few resources, while the newer cards are underutilized.

Therefore, as the software configuration changes, or hardware is added, it may become necessary to rebalance processes among the available in .

Reoptimizing Process Placements

The easiest and most reliable method for users to redistribute processes among the available in is with the **placement reoptimize** command.

During router operation, the actual resource usage of each process is collected and compared to the router configuration and network topology. An ideal configuration for process placement is created and updated in real time.

To implement this ideal process placement configuration, enter the **placement reoptimize** command in EXEC mode. Before the changes are made, the system displays a summary of the predicted changes. You can either accept the changes or cancel the operation.

See Reoptimizing Process Placement, on page 11 for detailed instructions.

Reconfiguring Process Placements

You can also change the process placement *affinities*, or preferences, to override the default policies. For example, you may learn that some processes perform better on the primary node pair, or that some processes have better high-availability characteristics when running on a paired node (a node with a standby partner). Other processes might benefit from co-location or by being assigned to nodes far apart from each other.

Note Consult with your technical support representative before changing the default process placement configuration. Incorrect configurations can cause system error, poor performance or downtime.

Recommended Guidelines for Process Placement

The following are a few recommended guidelines for changes to the process placement configuration:

- Generally, the process placement feature functions well upon system startup; fine tuning is seldom required.
- Use the EXEC mode command **placement reoptimize** , as described in the Reoptimizing Process Placements , on page 9 to automatically redistribute the processes among the available .
- Keep process placement policy changes to a minimum, and always consult technical support personnel before implementation.

Process Placement Based on Memory Consumption

You can change process placements based on memory use of processes. Memory use is expressed in terms of the memory “footprint of the placeable process. The system attempts to spread the load among the nodes without exceeding their memory capacity. In addition, the system computes the affinity values to determine the best placement.

Cisco IOS XR software assumes that every placeable process uses one megabyte of memory.

For detailed instructions, see Setting Memory Consumption Thresholds, on page 12.

Changing Process Affinities

Process placement can also be controlled by changing the *affinities*, or preferences, of a process or process group. The following types of process affinities are operator configurable:

- affinity location set
- affinity location type
- affinity program
- affinity self

affinity location set

This affinity specifies a preference for a process to run on a specific node pair or set of node pairs. A node pair is either an active and standby pair of nodes [hosted on], or a single active node on an that does not have a standby.

affinity location type

This affinity specifies a preference for a process to run on a particular location type. Available location types are as follows:

- **paired—** nodes that have an associated standby node
- **primary—**Primary node

- **current —**Current node. A process's affinity to its current node characterizes its preference to remain on the same node where possible.

You configure the placement policy to allow certain processes to stay where they are (**current**) or move by specifying the various affinity values. The higher the positive value of an affinity, the stronger the requirement that the process run at a location, and so on. A low or zero point value indicates a weaker requirement (or no preference) that a process run at a location.

affinity program

This affinity specifies a preference for a process to run on the same node as another process, or to run on a different node than another process. You would want to use this affinity in the case that certain processes perform better when they are running together on the same node (**attract**); or on different nodes, apart from each other (**repulse**).

affinity self

This affinity adjusts placement decisions when multiple instances of a process are started. An attract (positive) affinity indicates a preference to have all instances of a process run on the same node, while a repulse (negative) affinity indicates a preference to have each instance of a process run on different nodes.

Hierarchical Placement Policy

When you configure placement policies, you must remember that affinities are applied to the software in a hierarchical way.

Affinities applied to process instances take precedence over affinities applied to a process class. In the following example, all OSPF instances have a preference to run on the primary of the , but only OSPF instance 10 has a preference to run on a paired node:

```
RP/0/RP0/CPU0:router(config)# placement program ospf
RP/0/RP0/CPU0:router(config-place)# affinity location-type primary attract 200

RP/0/RP0/CPU0:router(config)# placement program ospf instance 10
RP/0/RP0/CPU0:router(config-place)# affinity location-type paired attract 200
```

Class affinities take precedence over default process affinities. In the following example, all OSPF instances have a preference to be placed on unpaired nodes. This overrides the default policy for all processes to prefer paired nodes.

```
RP/0/RP0/CPU0:router(config)# placement program ospf
RP/0/RP0/CPU0:router(config-place)# affinity location-type paired repulse 200
```

How to Configure Cisco IOS XR Process Placement

Reoptimizing Process Placement

This task reoptimizes the placeable processes among the available nodes according to memory and CPU usage.

SUMMARY STEPS

1. **placement reoptimize**
2. Use one of the following commands:
   - **yes**
   - **no**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**placement reoptimize** **Example:** `RP/0/RP0/CPU0:router# placement reoptimize`	Displays the predicted changes of the optimization.
Step 2	Use one of the following commands: • **yes** • **no** **Example:** `RP/0/RP0/CPU0:router# yes`	Accepts or rejects the changes.

Setting Memory Consumption Thresholds

SUMMARY STEPS

1. **show placement policy global**
2. **configure**
3. **placement memory** {**maximum** | **threshold**} *value*
4. Use one of the following commands:
   - **end**
   - **commit**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**show placement policy global** **Example:** `RP/0/RP0/CPU0:router# show placement policy global`	Displays the current memory settings.
Step 2	**configure**	
Step 3	**placement memory** {**maximum** | **threshold**} *value* **Example:** `RP/0/RP0/CPU0:router(config)# placement memory maximum 80`	Use **maximum** *value* keyword and argument to set the maximum percentage of memory that can be used on a node (based on the estimated memory usage of the processes). Use the **threshold** *value* keyword and argument to define the memory load level to trigger migration. The system attempts to balance all nodes at or below the threshold memory percentage. In other words, the system does not place a process on a node that has exceeded the threshold value, unless all other nodes have also reached their thresholds (or unless some other large affinity overrides this consideration).

Step 4	Use one of the following commands:
	• **end**
	• **commit**
	
	Example:
	`RP/0/RP0/CPU0:router(config-place)# end`
	or
	`RP/0/RP0/CPU0:router(config-place)# 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.

Creating a Location Set Affinity

This task sets the affinity of a placement program (process) to or from node pairs.

SUMMARY STEPS

1. **configure**
2. **placement program** {*program* [**instance** *instance*] | **default**}
3. **affinity location-set** *node-id1* [*node-id2*] {**attract** *strength* | **repulse** *strength* | **default** | **none**}
4. Use one of the following commands:
   - **end**
   - **commit**
5. **show placement location** {*node-id* | **all**}
6. **show placement program** {*program* | **all**}

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure**	
Step 2	**placement program** {*program* [**instance** *instance*]	**default**} **Example:** `RP/0/RP0/CPU0:router(config)# placement program ospf`	Enters placement program configuration mode.
Step 3	**affinity location-set** *node-id1* [*node-id2*] {**attract** *strength*	**repulse** *strength*	**default**	**none**} **Example:** `RP/0/RP0/CPU0:router(config-place)# affinity location-set 0/1/cpu0 0/1/cpu1 attract 200`	Sets the affinity of a placement program (process) to or from node pairs. To specify multiple nodes, enter the value of the *node-id* argument for each node. You can specify up to 5 nodes.

Step 4	Use one of the following commands:
	• **end**
	• **commit**
	
	Example:
	`RP/0/RP0/CPU0:router(config-place)# end`
	or
	`RP/0/RP0/CPU0:router(config-place)# 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.

	Command or Action	Purpose
		• Use the **commit** command to save the configuration changes to the running configuration file and remain within the configuration session.
Step 5	**show placement location** {*node-id* | **all**} **Example:** `RP/0/RP0/CPU0:router# show placement location all`	Displays the location of a placement process.
Step 6	**show placement program** {*program* | **all**} **Example:** `RP/0/RP0/CPU0:router# show placement program ospf`	Displays the operational state for each placement program.

Creating a Location Type Affinity

This task sets affinity of a placement program (process) to or from a location type.

SUMMARY STEPS

1. **configure**
2. **placement program** {*program* [**instance** *instance*] | **default**}
3. **affinity location-type** {**current** | **paired** | **primary**} {**attract** *strength* | **repulse** *strength* | **default** | **none**}
4. Use one of the following commands:
   - **end**
   - **commit**
5. **show placement location** {*node-id* | **all**}
6. **show placement program** {*program* | **all**}

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure**	
Step 2	**placement program** {*program* [**instance** *instance*]	**default**} **Example:** `RP/0/RP0/CPU0:router(config)# placement program bgp`	Enters placement program configuration mode.

	Command or Action	Purpose
Step 3	**affinity location-type** {**current** | **paired** | **primary**} {**attract** *strength* | **repulse** *strength* | **default** | **none**} **Example:** `RP/0/RP0/CPU0:router(config-place)# affinity location-type current attract 10`	Sets the affinity of a placement program (process) to or from a location type. • This example shows how to place Border Gateway Protocol (BGP) in the most optimal location at run time when load balancing is required. BGP will not be tied to a node pair but move when necessary.

Step 4	Use one of the following commands:
	• **end**
	• **commit**
	
	Example:
	`RP/0/RP0/CPU0:router(config-place)# end`
	or
	`RP/0/RP0/CPU0:router(config-place)# 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.

Step 5	**show placement location** {*node-id* | **all**} **Example:** `RP/0/RP0/CPU0:router# show placement location all`	Displays the location of a placement process.
Step 6	**show placement program** {*program* | **all**} **Example:** `RP/0/RP0/CPU0:router# show placement program bgp`	Displays the operational state for each placement program.

Creating a Program Affinity

This task sets the affinity of a placement program (process) to or from another program.

SUMMARY STEPS

1. **configure**
2. **placement program** {*program* [**instance** *instance*] | **default**}
3. **affinity program** *program* {**attract** *strength* | **repulse** *strength* | **default** | **none**}
4. Use one of the following commands:
   - **end**
   - **commit**
5. **show placement location** {*node-id* | **all**}
6. **show placement program** {*program* | **all**}

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure**	
Step 2	**placement program** {*program* [**instance** *instance*]	**default**} **Example:** `RP/0/RP0/CPU0:router(config)# placement program ipv4_rib`	Enters placement program configuration mode.
Step 3	**affinity program** *program* {**attract** *strength*	**repulse** *strength*	**default**	**none**} **Example:** `RP/0/RP0/CPU0:router(config-place)# affinity program ipv6_rib repulse 200`	Sets the affinity of a placement program (process) to or from another program. • This example shows how to keep IPv4 and IPv6 Routing Information Bases (RIBs) apart.

Step 4	Use one of the following commands:
	• **end**
	• **commit**
	
	Example:
	`RP/0/RP0/CPU0:router(config-place)# end`
	or
	`RP/0/RP0/CPU0:router(config-place)# 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.

	Command or Action	Purpose
		• Use the **commit** command to save the configuration changes to the running configuration file and remain within the configuration session.
Step 5	**show placement location** {*node-id* | **all**} **Example:** `RP/0/RP0/CPU0:router# show placement location all`	Displays the location of a placement process.
Step 6	**show placement program** {*program* | **all**} **Example:** `RP/0/RP0/CPU0:router# show placement program all`	Displays the operational state for each placement program.

Creating a Self Affinity

This task sets the affinity of a placement program (process) to or from one of its own instances.

SUMMARY STEPS

1. **configure**
2. **placement program** *program* {**instance** *instance* | **default**}
3. **affinity self** {**attract** *strength*| **repulse** *strength* | **default** | **none**}
4. Use one of the following commands:
   - **end**
   - **commit**
5. **show placement location** {*node-id* | **all**}
6. **show placement program** {*program* | **all**}

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure**	
Step 2	**placement program** *program* {**instance** *instance* | **default**} **Example:** `RP/0/RP0/CPU0:router(config)# placement program bgp`	Enters placement program configuration mode.

	Command or Action	Purpose
Step 3	**affinity self** {**attract** *strength*| **repulse** *strength* | **default** | **none**} **Example:** `RP/0/RP0/CPU0:router(config-place)# affinity self repulse 200`	Sets the affinity of a placement program (process) to or from one of its own instances.

Step 4	Use one of the following commands:
	• **end**
	• **commit**
	
	Example:
	`RP/0/RP0/CPU0:router(config-place)# end`
	or
	`RP/0/RP0/CPU0:router(config-place)# 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.

Step 5	**show placement location** {*node-id* | **all**} **Example:** `RP/0/RP0/CPU0:router# show placement location all`	Displays the location of a placement process.
Step 6	**show placement program** {*program* | **all**} **Example:** `RP/0/RP0/CPU0:router# show placement program bgp`	Displays the operational state for each placement program.

Configuration Examples for Process Placement

This section contains examples to view the processes that are placeable in an SDR.

If you believe that a custom reconfiguration of the processes on your system is required, you should work closely with Cisco personnel to ensure that the impact to your system is contained to just an instance of a process to avoid any undesirable results.

To learn the processes that are placeable, enter the **show placement program all** command in EXEC mode.

```
RP/0/RP0/CPU0:router# show placement program all

  Mon Aug 18 17:13:15.155 PST DST

  If a program is shown as having 'rejected locations' (i.e., locations on which
  it cannot be placed), the locations in question can been seen using the "show
  placement policy program" command.

  If a program has been placed but not yet started, the amount of time elapsed
  since the program was placed is shown in the 'waiting to start' field.

  Parentheses around the node indicate that the node has not yet fully booted.
    This will be true of standby nodes.

  Program                        Placed at location            # rejected  Waiting
                                                               locations   to start
  ------------------------------------------------------------------------------
  li_mgr                         0/RP0/CPU0 (0/RP1/CPU0)
  rsi_master                     0/RP0/CPU0 (0/RP1/CPU0)
  statsd_manager                 0/RP0/CPU0 (0/RP1/CPU0)
  ipv4_rib                       0/RP0/CPU0 (0/RP1/CPU0)
  ipv6_rib                       0/RP0/CPU0 (0/RP1/CPU0)
  policy_repository              0/RP0/CPU0 (0/RP1/CPU0)
  ipv4_mpa                       0/RP0/CPU0 (0/RP1/CPU0)
  ipv6_mpa                       0/RP0/CPU0 (0/RP1/CPU0)
  bfd                            0/RP0/CPU0 (0/RP1/CPU0)
  domain_services                0/RP0/CPU0 (0/RP1/CPU0)
  ftp_fs                         0/RP0/CPU0 (0/RP1/CPU0)
  rcp_fs                         0/RP0/CPU0 (0/RP1/CPU0)
  tftp_fs                        0/RP0/CPU0 (0/RP1/CPU0)
  ipv4_connected                 0/RP0/CPU0 (0/RP1/CPU0)
  ipv4_local                     0/RP0/CPU0 (0/RP1/CPU0)
  ipv4_rump                      0/RP0/CPU0 (0/RP1/CPU0)
  ipv6_connected                 0/RP0/CPU0 (0/RP1/CPU0)
  ipv6_local                     0/RP0/CPU0 (0/RP1/CPU0)
  ipv6_rump                      0/RP0/CPU0 (0/RP1/CPU0)
  atmgcmgr                       0/RP0/CPU0 (0/RP1/CPU0)
  eem_metric_dir                 0/RP0/CPU0 (0/RP1/CPU0)
  l2tp_mgr                       0/RP0/CPU0 (0/RP1/CPU0)
  l2vpn_mgr                      0/RP0/CPU0 (0/RP1/CPU0)
  rt_check_mgr                   0/RP0/CPU0 (0/RP1/CPU0)
  ipv4_static                    0/RP0/CPU0 (0/RP1/CPU0)
  isis instance lab              0/RP0/CPU0 (0/RP1/CPU0)
  ospf instance 100              0/RP0/CPU0 (0/RP1/CPU0)
  isis_uv                        0/RP0/CPU0 (0/RP1/CPU0)
  ospf_uv                        0/RP0/CPU0 (0/RP1/CPU0)
  mpls_vpn_mib                   0/RP0/CPU0 (0/RP1/CPU0)
  rsvp                           0/RP0/CPU0 (0/RP1/CPU0)
  mpls_ldp                       0/RP0/CPU0 (0/RP1/CPU0)
  lspv_server                    0/RP0/CPU0 (0/RP1/CPU0)
  ospf instance 0                0/RP0/CPU0 (0/RP1/CPU0)
  ospfv3 instance 0              0/RP0/CPU0 (0/RP1/CPU0)
  ospfv3_uv                      0/RP0/CPU0 (0/RP1/CPU0)
```

Additional References

The following sections provide references related to Cisco IOS XR Process Placement.

Related Documents

Related Topic	Document Title
Cisco IOS XR process placement commands	*Process and Memory Management Commands on Cisco IOS XR software* module of *System Management Command Reference for Cisco NCS 6000 Series Routers*
Cisco IOS XR master command index	
Getting started with Cisco IOS XR software	
Information about user groups and task IDs	*Configuring AAA Services on Cisco IOS XR software* module of *System Security Configuration Guide for Cisco NCS 6000 Series Routers*

Standards

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

MIBs

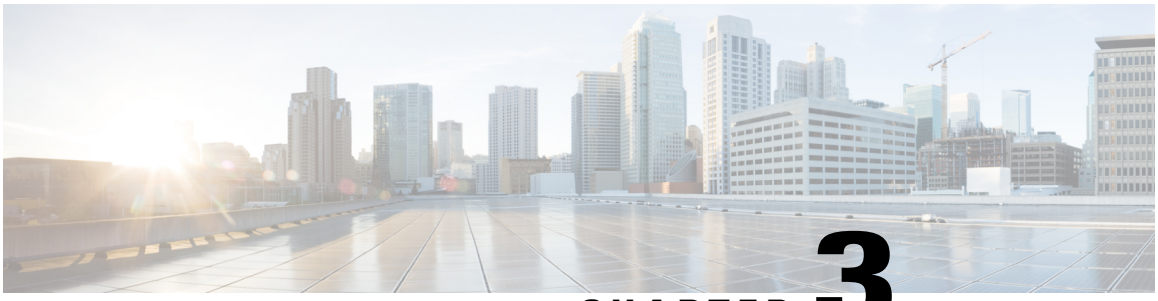
MIBs	MIBs Link
—	To locate and download MIBs using Cisco IOS XR software, use the Cisco MIB Locator found at the following URL and choose a platform under the Cisco Access Products menu: http://cisco.com/public/sw-center/netmgmt/cmtk/mibs.shtml

RFCs

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

Technical Assistance

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



CHAPTER 3

Configuring Manageability

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

- DOM allows customers to programmatically create, manipulate, and generate XML documents.
- SAX supports user-defined functions for XML tags.
- DTD allows for validation of defined document types.

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

Release 5.0.0	This feature was introduced.

This module contains the following topics:

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

	Command or Action	Purpose
Step 1	**xml agent** [**ssl**] **Example:** `RP/0/RP0/CPU0:router:router(config)# xml agent`	Enables Extensible Markup Language (XML) requests over a dedicated TCP connection and enters XML agent configuration mode. Use the **ssl** keyword to enable XML requests over Secure Socket Layer (SSL).
Step 2	**iteration on size** *iteration-size* **Example:** `RP/0/RP0/CPU0:router:router(config-xml-agent)# iteration on size 500`	Configures the iteration size for large XML agent responses in KBytes. The default is 48.
Step 3	**session timeout** *timeout* **Example:** `RP/0/RP0/CPU0:router:router(config-xml-agent)# session timeout 5`	Configures an idle timeout for the XML agent in minutes. By default, there is no timeout.
Step 4	**throttle** {**memory** *size*	**process-rate** *tags*} **Example:** `RP/0/RP0/CPU0:router:router(config-xml-agent)# throttle memory 300`	Configures the XML agent processing capabilities. • Specify the memory size in Mbytes. Values can range from 100 to 600. The default is 300. • Specify the process-rate as the number of tags that the XML agent can process per second. Values can range from 1000 to 30000. By default the process rate is not throttled.
Step 5	**vrf** { **default**	*vrf-name*} [**access-list** *access-list-name*] **Example:** `RP/0/RP0/CPU0:router:router(config-xml-agent)# vrf my-vrf`	Configures the dedicated agent or SSL agent to receive and send messages via the specified VPN routing and forwarding (VRF) instance.

Configuration Examples for Manageability

Enabling VRF on an XML Agent: Examples

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

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

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

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

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

```
RP/0/RP0/CPU0:router:router(config)# xml agent ssl
RP/0/RP0/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

Related Topic	Document Title
Cisco IOS XR commands	
Information about user groups and task IDs	*Configuring AAA Services on Cisco IOS XR Software* module of *System Security Configuration Guide for Cisco NCS 6000 Series Routers*

Standards and RFCs

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

MIBs

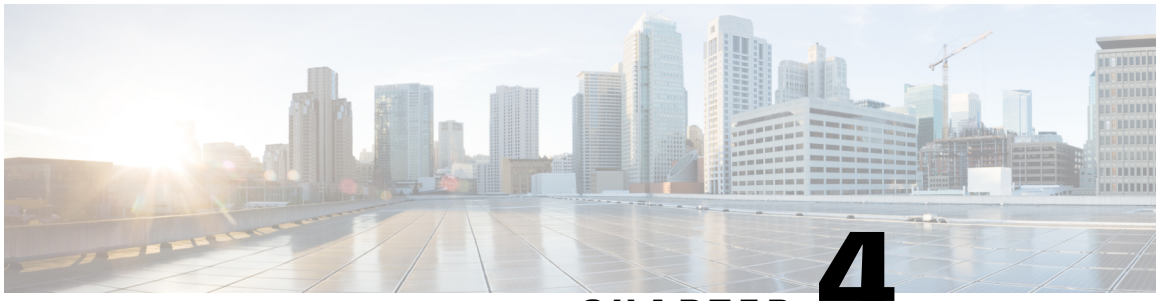
MIB	MIBs Link
—	To locate and download MIBs for selected platforms, Cisco IOS releases, and feature sets, use Cisco MIB Locator found at the following URL: http://www.cisco.com/go/mibs

RFCs

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

Technical Assistance

Description	Link
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.	http://www.cisco.com/cisco/web/support/index.html



CHAPTER 4

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 46. To locate documentation for other commands that might appear in the course of running a configuration task, search online in .

Table 5: Feature History for Implementing NTP on Cisco IOS XR Software

Release	Modification
Release 5.0.0	This feature was introduced.

This module contains the following topics:

Prerequisites for Implementing NTP on Cisco IOS XR Software

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

Information About Implementing NTP

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

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

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

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

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

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

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

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

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

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

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

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

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

	Command or Action	Purpose
Step 1	**configure**	
Step 2	**ntp** **Example:** `RP/0/RP0/CPU0:router(config)# ntp`	Enters NTP configuration mode.

Step 3	**server** *ip-address* [**version** *number*] [**key** *key-id*] [**minpoll** *interval*] [**maxpoll** *interval*] [**source** *type interface-path-id*] [**prefer**] [**burst**] [**iburst**]
	
	Example:
	`RP/0/RP0/CPU0:router(config-ntp)# server 172.16.22.44`
	`  minpoll 8 maxpoll 12`
		Forms a server association with another system. This step can be repeated as necessary to form associations with multiple devices.

Step 4	**peer** *ip-address* [**version** *number*] [**key** *key-id*] [**minpoll** *interval*] [**maxpoll** *interval*] [**source** *type interface-path-id*] [**prefer**]
	
	Example:
	`RP/0/RP0/CPU0:router(config-ntp)# peer 192.168.22.33`
	`  minpoll 8 maxpoll 12 source tengige 0/0/0/1`
		Forms a peer association with another system. This step can be repeated as necessary to form associations with multiple systems.
		Note To complete the configuration of a peer-to-peer association between the router and the remote device, the router must also be configured as a peer on the remote device.

Step 5	Use one of the following commands: • **end** • **commit**	Saves configuration changes. • When you issue the **end** command, the system prompts you to commit changes: `Uncommitted changes found, commit them before`

	Command or Action	Purpose

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

Configuring Broadcast-Based NTP Associates

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

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

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

Use the **broadcast** command to set your networking device to send NTP broadcast packets.

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

SUMMARY STEPS

1. **configure**
2. **ntp**
3. (Optional) **broadcastdelay** *microseconds*
4. **interface** *type interface-path-id*
5. **broadcast client**
6. **broadcast** [**destination** *ip-address*] [**key** *key-id*] [**version** *number*]
7. Use one of the following commands:
   - **end**
   - **commit**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure**	
Step 2	**ntp** **Example:** `RP/0/RP0/CPU0:router(config)# ntp`	Enters NTP configuration mode.
Step 3	**broadcastdelay** *microseconds* **Example:** `RP/0/RP0/CPU0:router(config-ntp)# broadcastdelay 5000`	(Optional) Adjusts the estimated round-trip delay for NTP broadcasts.
Step 4	**interface** *type interface-path-id* **Example:** `RP/0/RP0/CPU0:router(config-ntp)# interface POS 0/1/0/0`	Enters NTP interface configuration mode.
Step 5	**broadcast client** **Example:** `RP/0/RP0/CPU0:router(config-ntp-int)# broadcast client`	Configures the specified interface to receive NTP broadcast packets. **Note** Go to Step 6, on page 32 to configure the interface to send NTP broadcast packets.
Step 6	**broadcast** [**destination** *ip-address*] [**key** *key-id*] [**version** *number*] **Example:** `RP/0/RP0/CPU0:router(config-ntp-int)#`	Configures the specified interface to send NTP broadcast packets. **Note** Go to Step 5, on page 32 to configure the interface to receive NTP broadcast packets.

	Command or Action	Purpose
	`broadcast destination 10.50.32.149`	

Step 7	Use one of the following commands:
	• **end**
	• **commit**
	Example:
	`RP/0/RP0/CPU0:router(config-ntp-int)# end`
	or
	`RP/0/RP0/CPU0:router(config-ntp-int)# commit`
		Saves configuration changes.
		• When you issue the **end** command, the system prompts you to commit changes:
		`Uncommitted changes found, commit them before exiting(yes/no/cancel)? [cancel]:`
		◦ Entering **yes** saves configuration changes to the running configuration file, exits the configuration session, and returns the router to EXEC mode.
		◦ Entering **no** exits the configuration session and returns the router to EXEC mode without committing the configuration changes.
		◦ Entering **cancel** leaves the router in the current configuration session without exiting or committing the configuration changes.
		• Use the **commit** command to save the configuration changes to the running configuration file and remain within the configuration session.

Configuring NTP Access Groups

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

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

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

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

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

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

SUMMARY STEPS

1. **configure**
2. **ntp**
3. **access-group**{**peer** | **query-only** | **serve** | **serve-only**} *access-list-name*
4. Use one of the following commands:
   - **end**
   - **commit**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure**	
Step 2	**ntp** **Example:** `RP/0/RP0/CPU0:router(config)# ntp`	Enters NTP configuration mode.
Step 3	**access-group**{**peer**	**query-only**	**serve**	**serve-only**} *access-list-name* **Example:** `RP/0/RP0/CPU0:router(config-ntp)# access-group peer access1`	Creates an access group and applies a basic IPv4 or IPv6 access list to it.

Step 4	Use one of the following commands:
	• **end**
	• **commit**
	
	Example:
	`RP/0/RP0/CPU0:router(config-ntp)# end`
	or
	`RP/0/RP0/CPU0:router(config-ntp)# commit`
		Saves configuration changes.
		• When you issue the **end** command, the system prompts you to commit changes:
		`Uncommitted changes found, commit them before exiting(yes/no/cancel)? [cancel]:`
		◦ Entering **yes** saves configuration changes to the running configuration file, exits the configuration session, and returns the router to EXEC mode.
		◦ Entering **no** exits the configuration session and returns the router to EXEC mode without committing the configuration changes.

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

Configuring NTP Authentication

This task explains how to configure NTP authentication.

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

The encrypted NTP authentication scheme should be used when a reliable form of access control is required. Unlike the access-list-based restriction scheme that is based on IP addresses, the encrypted authentication scheme uses authentication keys and an authentication process to determine if NTP synchronization packets sent by designated peers or servers on a local network are deemed as trusted, before the time information that it carries along is accepted.

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

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

SUMMARY STEPS

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

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure**	
Step 2	**ntp** **Example:** `RP/0/RP0/CPU0:router(config)# ntp`	Enters NTP configuration mode.
Step 3	**authenticate** **Example:** `RP/0/RP0/CPU0:router(config-ntp)# authenticate`	Enables the NTP authentication feature.
Step 4	**authentication-key** *key-number* **md5** [**clear** | **encrypted**] *key-name* **Example:** `RP/0/RP0/CPU0:router(config-ntp)# authentication-key 42 md5 clear key1`	Defines the authentication keys. • Each key has a key number, a type, a value, and, optionally, a name. Currently the only key type supported is **md5**.
Step 5	**trusted-key** *key-number* **Example:** `RP/0/RP0/CPU0:router(config-ntp)# trusted-key 42`	Defines trusted authentication keys. • If a key is trusted, this router only synchronizes to a system that uses this key in its NTP packets.

Step 6	Use one of the following commands:
	• **end**
	• **commit**
	
	Example:
	`RP/0/RP0/CPU0:router(config-ntp)# end`
	or
	`RP/0/RP0/CPU0:router(config-ntp)# commit`
		Saves configuration changes.
		• When you issue the **end** command, the system prompts you to commit changes:
		`Uncommitted changes found, commit them before exiting(yes/no/cancel)? [cancel]:`
		◦ Entering **yes** saves configuration changes to the running configuration file, exits the configuration session, and returns the router to EXEC mode.
		◦ Entering **no** exits the configuration session and returns the router to EXEC mode without committing the configuration changes.
		◦ Entering **cancel** leaves the router in the current configuration session without exiting or committing the configuration changes.

	Command or Action	Purpose
		• Use the **commit** command to save the configuration changes to the running configuration file and remain within the configuration session.

Disabling NTP Services on a Specific Interface

NTP services are disabled on all interfaces by default.

NTP is enabled globally when any NTP commands are entered. You can selectively prevent NTP packets from being received through a specific interface by turning off NTP on a given interface.

SUMMARY STEPS

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

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure**	
Step 2	**ntp** **Example:** `RP/0/RP0/CPU0:router(config)# ntp`	Enters NTP configuration mode.
Step 3	Use one of the following commands: • **no interface** *type interface-path-id* • **interface** *type interface-path-id* **disable**	Disables NTP services on the specified interface.

	Command or Action	Purpose

	Example:
	`RP/0/RP0/CPU0:router(config-ntp)# no interface pos 0/0/0/1`
	or
	`RP/0/RP0/CPU0:router(config-ntp)# interface POS 0/0/0/1 disable`	

Step 4	Use one of the following commands:
	• **end**
	• **commit**
	Example:
	`RP/0/RP0/CPU0:router(config-ntp)# end`
	or
	`RP/0/RP0/CPU0:router(config-ntp)# commit`
		Saves configuration changes.
		• When you issue the **end** command, the system prompts you to commit changes:
		`Uncommitted changes found, commit them before exiting(yes/no/cancel)? [cancel]:`
		◦ Entering **yes** saves configuration changes to the running configuration file, exits the configuration session, and returns the router to EXEC mode.
		◦ Entering **no** exits the configuration session and returns the router to EXEC mode without committing the configuration changes.
		◦ Entering **cancel** leaves the router in the current configuration session without exiting or committing the configuration changes.
		• Use the **commit** command to save the configuration changes to the running configuration file and remain within the configuration session.

Configuring the Source IP Address for NTP Packets

By default, the source IP address of an NTP packet sent by the router is the address of the interface through which the NTP packet is sent. Use this procedure to set a different source address.

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

SUMMARY STEPS

1. **configure**
2. **ntp**
3. **source** *type interface-path-id*
4. Use one of the following commands:
   - **end**
   - **commit**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure**	
Step 2	**ntp** **Example:** `RP/0/RP0/CPU0:router(config)# ntp`	Enters NTP configuration mode.
Step 3	**source** *type interface-path-id* **Example:** `RP/0/RP0/CPU0:router(config-ntp)# source POS 0/0/0/1`	Configures an interface from which the IP source address is taken. **Note** This interface is used for the source address for all packets sent to all destinations. If a source address is to be used for a specific association, use the **source** keyword in the **peer** or **server** command shown in Configuring Poll-Based Associations, on page 29.

Step 4	Use one of the following commands:
	• **end**
	• **commit**
	
	Example:
	`RP/0/RP0/CPU0:router(config-ntp)# end`
	or
	`RP/0/RP0/CPU0:router(config-ntp)# commit`
		Saves configuration changes.
		• When you issue the **end** command, the system prompts you to commit changes:
		`Uncommitted changes found, commit them before exiting(yes/no/cancel)? [cancel]:`
		◦ Entering **yes** saves configuration changes to the running configuration file, exits the configuration session, and returns the router to EXEC mode.
		◦ Entering **no** exits the configuration session and returns the router to EXEC mode without committing the configuration changes.
		◦ Entering **cancel** leaves the router in the current configuration session without exiting or committing the configuration changes.
		• Use the **commit** command to save the configuration changes to the running configuration file and remain within the configuration session.

Configuring the System as an Authoritative NTP Server

You can configure the router to act as an authoritative NTP server, even if the system is not synchronized to an outside time source.

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

SUMMARY STEPS

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

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure**	
Step 2	**ntp** **Example:** `RP/0/RP0/CPU0:router(config)# ntp`	Enters NTP configuration mode.
Step 3	**master** *stratum* **Example:** `RP/0/RP0/CPU0:router(config-ntp)# master 9`	Makes the router an authoritative NTP server. **Note** Use the **master** command with caution. It is very easy to override valid time sources using this command, especially if a low stratum number is configured. Configuring multiple machines in the same network with the **master** command can cause instability in time keeping if the machines do not agree on the time.
Step 4	Use one of the following commands: • **end** • **commit**	Saves configuration changes. • When you issue the **end** command, the system prompts you to commit changes: `Uncommitted changes found, commit them before`

	Command or Action	Purpose

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

	Command or Action	Purpose
Step 1	**configure**	

	Command or Action	Purpose
Step 2	**ntp** **Example:** `RP/0/RP0/CPU0:router(config)# ntp`	Enters NTP configuration mode.
Step 3	**update-calendar** **Example:** `RP/0/RP0/CPU0:router(config-ntp)# update-calendar`	Configures the router t o update its system calendar from the software clock at periodic intervals.

Step 4	Use one of the following commands:
	• **end**
	• **commit**
	
	Example:
	
	`RP/0/RP0/CPU0:router(config-ntp)# end`
	or
	
	`RP/0/RP0/CPU0:router(config-ntp)# commit`
		Saves configuration changes.
		• When you issue the **end** command, the system prompts you to commit changes:
		
		`Uncommitted changes found, commit them before exiting(yes/no/cancel)? [cancel]:`
		
		◦ Entering **yes** saves configuration changes to the running configuration file, exits the configuration session, and returns the router to EXEC mode.
		◦ Entering **no** exits the configuration session and returns the router to EXEC mode without committing the configuration changes.
		◦ Entering **cancel** leaves the router in the current configuration session without exiting or committing the configuration changes.
		• Use the **commit** command to save the configuration changes to the running configuration file and remain within the configuration session.

Verifying the Status of the External Reference Clock

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

Note The commands can be entered in any order.

SUMMARY STEPS

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

DETAILED STEPS

	Command or Action	Purpose
Step 1	**show ntp associations** [**detail**] [**location** *node-id*] **Example:** `RP/0/RP0/CPU0:router# show ntp associations`	Displays the status of NTP associations.
Step 2	**show ntp status** [**location** *node-id*] **Example:** `RP/0/RP0/CPU0:router# show ntp status`	Displays the status of NTP.

Examples

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

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

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.

```
ntp
  authenticate
  authentication-key 2 md5 encrypted 06120A2D40031D1008124
  authentication-key 3 md5 encrypted 1311121E074110232621
  trusted-key 3
  server 10.3.32.154 key 3
  peer 10.32.154.145 key 2
```

Disabling NTP on an Interface: Example

The following example shows an NTP configuration in which 0/2/0/0 interface is disabled:

```
ntp
  interface tengige 0/2/0/0
    disable
    exit
  authentication-key 2 md5 encrypted 06120A2D40031D1008124
  authentication-key 3 md5 encrypted 1311121E074110232621
  authenticate
  trusted-key 3
  server 10.3.32.154 key 3
  peer 10.32.154.145 key 2
```

Configuring the Source IP Address for NTP Packets: Example

The following example shows an NTP configuration in which Ethernet management interface 0/0/CPU0/0 is configured as the source address for NTP packets:

```
ntp
  authentication-key 2 md5 encrypted 06120A2D40031D1008124
  authentication-key 3 md5 encrypted 1311121E074110232621
  authenticate
  trusted-key 3
  server 10.3.32.154 key 3
  peer 10.32.154.145 key 2
  source MgmtEth0/0/CPU0/0
```

Configuring the System as an Authoritative NTP Server: Example

The following example shows a NTP configuration in which the router is configured to use its own NTP master clock to synchronize with peers when an external NTP source becomes unavailable:

```
ntp
  master 6
```

Updating the Hardware Clock: Example

The following example shows an NTP configuration in which the router is configured to update its hardware clock from the software clock at periodic intervals:

```
ntp
  server 10.3.32.154
  update-calendar
```

Additional References

The following sections provide references related to implementing NTP on Cisco IOS XR software.

Related Documents

Related Topic	Document Title
Cisco IOS XR clock commands	*Clock Commands on* module of *System Management Command Reference for Cisco NCS 6000 Series Routers*
Cisco IOS XR NTP commands	*NTP Commands on* module of *System Management Command Reference for Cisco NCS 6000 Series Routers*
Information about getting started with Cisco IOS XR Software	
Cisco IOS XR master command index	
Information about user groups and task IDs	*Configuring AAA Services on* module of *System Security Configuration Guide for Cisco NCS 6000 Series Routers*

Standards

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

MIBs

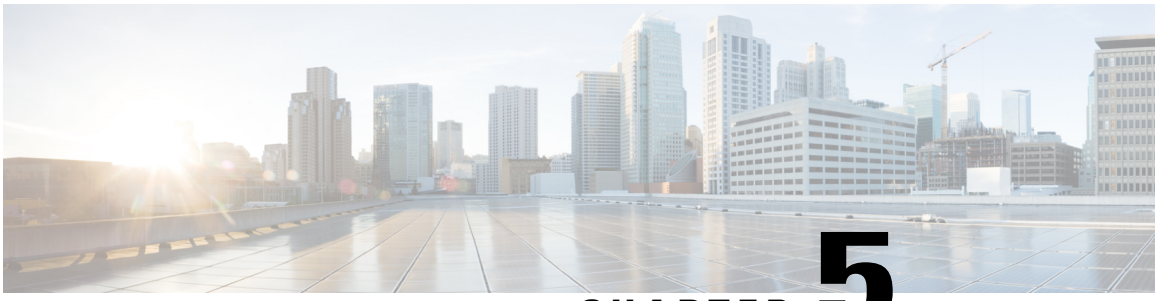
MIBs	MIBs Link
—	To locate and download MIBs using Cisco IOS XR software, use the Cisco MIB Locator found at the following URL and choose a platform under the Cisco Access Products menu: http://cisco.com/public/sw-center/netmgmt/cmtk/mibs.shtml

RFCs

RFCs	Title
RFC 1059	*Network Time Protocol, Version 1: Specification and Implementation*
RFC 1119	*Network Time Protocol, Version 2: Specification and Implementation*
RFC 1305	*Network Time Protocol, Version 3: Specification, Implementation, and Analysis*

Technical Assistance

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



CHAPTER 5

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.

Note Before creating or modifying the vty pools, enable the telnet server using the **telnet server** command in XR Config mode. See *IP Addresses and Services Configuration Guide for Cisco NCS 6000 Series Routers* and *IP Addresses and Services Command Reference for Cisco NCS 6000 Series Routers* for more information.

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

For more information about physical and virtual terminals on the Cisco IOS XR software and complete descriptions of the terminal services commands listed in this module, see Related Documents, on page 58. To locate documentation for other commands that might appear in the course of running a configuration task, search online in .

Table 6: Feature History for Implementing Physical and Virtual Templates on Cisco IOS XR Software

Release	Modification
Release 5.0.0	This feature was introduced.

This module contains the following topics:

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 XR Config mode, specifying the template to be modified. These line templates can be configured with the **line** command:

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

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

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

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

- absolute-timeout—Specifies a timeout value for line disconnection.
- escape-character—Changes the line escape character.
- exec-timeout—Specifies the EXEC timeout.
- length—Sets the number of lines displayed on the screen.

- session-limit—Specifies the allowable number of outgoing connections.
- session-timeout—Specifies an interval for closing the connection if there is no input traffic.
- timestamp—Displays the timestamp before each command.
- width—Specifies the width of the display terminal.

Line Template Guidelines

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

- Modify the templates for the physical terminal lines on the router (the console port) from line template configuration mode. Use the **line console** command from XR Config mode to enter line template configuration mode for the console template.
- Modify the template for virtual lines by configuring a user-defined template with the **line** *template-name* command, configuring the terminal attributes for the user-defined template from line template configuration, and applying the template to a range of virtual terminal lines using the **vty pool** command.

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

The default settings for the default template are described for all commands in line template configuration mode in the *Terminal Services Commands on* module in *System Management Command Reference for Cisco NCS 6000 Series Routers*.

Note Before creating or modifying the vty pools, enable the telnet server using the **telnet server** command in XR Config mode. See *IP Addresses and Services Configuration Guide for Cisco NCS 6000 Series Routers* and *IP Addresses and Services Command Reference for Cisco NCS 6000 Series Routers* for more information.

Terminal Identification

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

vty Pools

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

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

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

When configuring vty pools, follow these guidelines:

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

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

Modifying Templates

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

SUMMARY STEPS

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

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure**	
Step 2	**line** {**console**	**default**}	Enters line template configuration mode for the specified line template.

	Command or Action	Purpose

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

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

Step 4	Use one of the following commands:
	• **end**
	• **commit**
	Example:
	`RP/0/RP0/CPU0:router(config-line)# end`
	or
	`RP/0/RP0/CPU0:router(config-line)# 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.

Creating and Modifying vty Pools

This task explains how to create and modify vty pools.

You can omit Step 3, on page 54 to Step 5, on page 54 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

	Command or Action	Purpose
Step 1	**configure**	
Step 2	**telnet** {**ipv4**	**ipv6**} **server max-servers** *limit* **Example:** `RP/0/RP0/CPU0:router(config)# telnet ipv4 server max-servers 10`	Specifies the number of allowable Telnet servers. Up to 100 Telnet servers are allowed. **Note** By default no Telnet servers are allowed. You must configure this command in order to enable the use of Telnet servers.
Step 3	**line template** *template-name* **Example:** `RP/0/RP0/CPU0:router(config)# line template 1`	Enters line template configuration mode for a user-defined template.
Step 4	Configure the terminal attribute settings for the specified line template using the commands in line template configuration mode.	—
Step 5	**exit** **Example:** `RP/0/RP0/CPU0:router(config-line)# exit`	Exits line template configuration mode and returns the router to global configuration mode.

Step 6	**vty-pool** {**default**	*pool-name*	**eem**} *first-vty last-vty* [**line-template** {**default**	*template-name*}]
				
				Example:
				`RP/0/RP0/CPU0:router(config)# vty-pool default 0 5 line-template default`
				or
				`RP/0/RP0/CPU0:router(config)# vty-pool pool1 5 50 line-template template1`
					Creates or modifies vty pools.
					• If you do not specify a line template with the **line-template** keyword, a vty pool defaults to the default line template.
					• **default —**Configures the default vty pool.
					◦ The default vty pool must start at vty 0 and must contain a minimum of five vtys (vtys 0 through 4).
					◦ You can resize the default vty pool by increasing the range of vtys that compose the default vty pool.

	Command or Action	Purpose
	or `RP/0/RP0/CPU0:router(config)# vty-pool eem 100 105 line-template template1`	• *pool-name* —Creates a user-defined vty pool. ◦ A user-defined pool must start at least at vty 5, depending on whether the default vty pool has been resized. ◦ If the range of vtys for the default vty pool has been resized, use the first range value free from the default line template. For example, if the range of vtys for the default vty pool has been configured to include 10 vtys (vty 0 through 9), the range value for the user-defined vty pool must start with vty 10. • **eem** —Configures the embedded event manager pool. ◦ The default embedded event manager vty pool must start at vty 100 and must contain a minimum of six vtys (vtys 100 through 105). • **line-template** *template-name* —Configures the vty pool to reference a user-defined template.
Step 7	**commit**	

Monitoring Terminals and Terminal Sessions

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

Note The commands can be entered in any order.

SUMMARY STEPS

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

DETAILED STEPS

	Command or Action	Purpose
Step 1	**show line** [**aux location** *node-id*	**console location** *node-id*	**vty** *number*]	(Optional) Displays the terminal parameters of terminal lines.

	Command or Action	Purpose
	Example: `RP/0/RP0/CPU0:router# show line`	• Specifying the **show line aux location** *node-id* EXEC command displays the terminal parameters of the auxiliary line. • Specifying the **show line console location** *node-id* EXEC command displays the terminal parameters of the console. ◦ For the **location** *node-id* keyword and argument, enter the location of the Route Processor (RP) on which the respective auxiliary or console port resides. ◦ The *node-id* argument is expressed in the format of *rack*/*slot*/*module* . • Specifying the **show line vty** *number* EXEC command displays the terminal parameters for the specified vty.
Step 2	**show terminal** **Example:** `RP/0/RP0/CPU0:router# show terminal`	(Optional) Displays the terminal attribute settings for the current terminal line.
Step 3	**show users** **Example:** `RP/0/RP0/CPU0:router# show users`	(Optional) Displays information about the active lines on the router.

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:

```
line console
  exec-timeout 0 0
  escape-character 0x5a
```

```
  session-limit 10
  disconnect-character 0x59
  session-timeout 100
  transport input telnet
  transport output telnet
```

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

- The EXEC time out for terminal sessions is set to 0 minutes, 0 seconds. Setting the EXEC timeout to 0 minutes and 0 seconds disables the EXEC timeout function; thus, the EXEC session for the terminal session will never time out.
- The escape character is set to the 0x5a hexadecimal value (the 0x5a hexadecimal value translates into the “Z” character).
- The session limit for outgoing terminal sessions is set to 10 connections.
- The disconnect character is set to 0x59 hexadecimal value (the 0x59 hexadecimal character translates into the “Y” character).
- The session time out for outgoing terminal sessions is set to 100 minutes (1 hour and 40 minutes).
- The allowed transport protocol for incoming terminal sessions is Telnet.
- The allowed transport protocol for outgoing terminal sessions is Telnet.

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

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

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

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

Modifying the Default Template: Example

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

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

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

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

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

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

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

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

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

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

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

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

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

Additional References

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

Related Documents

Related Topic	Document Title
Cisco IOS XR terminal services commands	*Terminal Services Commands on* module of *System Management Command Reference for Cisco NCS 6000 Series Routers*
Cisco IOS XR command master index	
Information about getting started with Cisco IOS XR software	

Related Topic	Document Title
Information about user groups and task IDs	*Configuring AAA Services on* module of *System Security Configuration Guide for Cisco NCS 6000 Series Routers*

Standards

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

MIBs

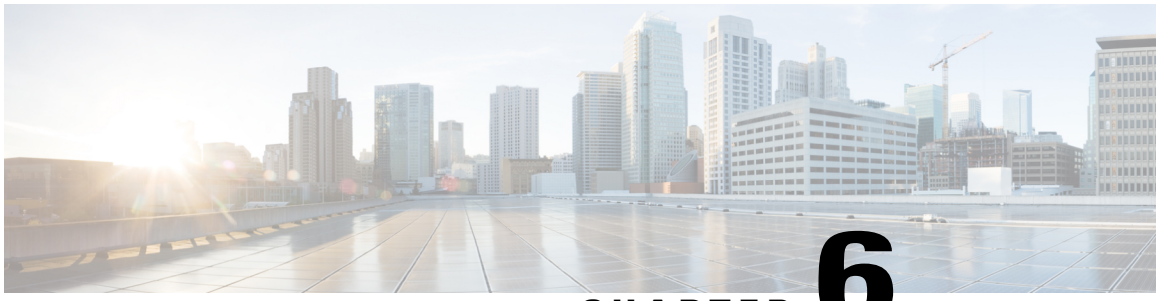
MIBs	MIBs Link
—	To locate and download MIBs using Cisco IOS XR software, use the Cisco MIB Locator found at the following URL and choose a platform under the Cisco Access Products menu: http://cisco.com/public/sw-center/netmgmt/cmtk/mibs.shtml

RFCs

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

Technical Assistance

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



CHAPTER 6

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 84. For information on specific MIBs, refer to . To locate documentation for other commands that might appear in the course of performing a configuration task, search online in .

Table 7: Feature History for Implementing SNMP on Cisco IOS XR Software

Release	Modification
Release 3.9.0	Support was added for 3DES and AES encryption. The ability to preserve ENTITY-MIB and CISCO-CLASS-BASED-QOS-MIB data was added.
Release 4.2.0	Support was added for SNMP over IPv6.

This module contains the following topics:

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

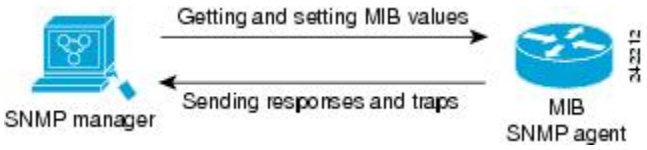
The *Management Information Base* (MIB) is a virtual information storage area for network management information, which consists of collections of managed objects. Within the MIB there are collections of related

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 1: Communication Between an SNMP Agent and Manager, on page 63 illustrates the communications relationship between the SNMP manager and agent. A manager can send the agent requests to get and set MIB values. The agent can respond to these requests. Independent of this interaction, the agent can send unsolicited notifications (traps) to the manager to notify the manager of network conditions.

Figure 1: Communication Between an SNMP Agent and Manager



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.

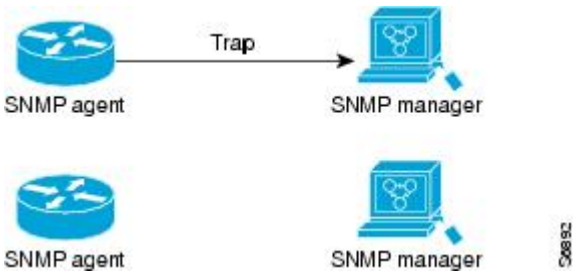
Note Inform requests (inform operations) are supported in Cisco IOS XR software from release 4.1 onwards. For more inf
http://www.cisco.com/c/en/us/td/docs/routers/asr9000/software/asr9k_r5-3/sysman/command/reference/b-sysman-cr53

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.

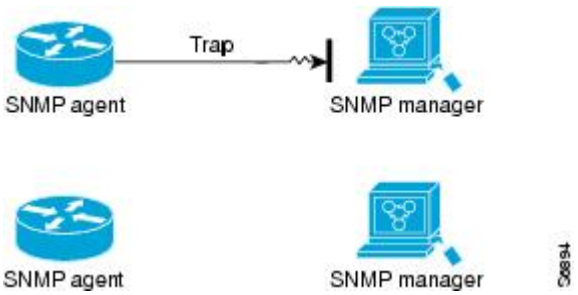
In this illustration, the agent router sends a trap to the SNMP manager. Although the manager receives the trap, it does not send any acknowledgment to the agent. The agent has no way of knowing that the trap reached its destination.

Figure 2: 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 3: Trap Not Received by the SNMP Manager



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 9: SNMP Security Models and Levels, on page 66 for a list of security levels available in SNMPv3. The SNMPv3 feature supports RFCs 3411 to 3418.

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

Comparison of SNMPv1, v2c, and v3

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

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

Table 8: SNMPv1, v2c, and v3 Feature Support, on page 65 identifies other key SNMP features supported by the SNMP v1, v2c, and v3.

Table 8: SNMPv1, v2c, and v3 Feature Support

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

Security Models and Levels for SNMPv1, v2, v3

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

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

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

Table 9: SNMP Security Models and Levels, on page 66 identifies what the combinations of security models and levels mean.

Table 9: SNMP Security Models and Levels

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

Model	Level	Authentication	Encryption	What Happens
v3	authPriv	HMAC-MD5 or HMAC-SHA	3DES	Provides authentication based on the HMAC-MD5 or HMAC-SHA algorithms. Provides 168-bit 3DES[6] level of encryption.
v3	authPriv	HMAC-MD5 or HMAC-SHA	AES	Provides authentication based on the HMAC-MD5 or HMAC-SHA algorithms. Provides 128-bit AES[7] level of encryption.

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

Use of 3DES and AES encryption standards requires that the security package (k9sec) be installed. For information on installing software packages, see *Upgrading and Managing Cisco IOS XR Software*.

SNMPv3 Benefits

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

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

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

SNMPv3 Costs

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

Table 10: Order of Response Times from Least to Greatest, on page 68 shows the order of response time (from least to greatest) for the various security model and security level combinations.

Table 10: Order of Response Times from Least to Greatest

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

User-Based Security Model

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

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

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

USM uses two authentication protocols:

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

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

View-Based Access Control Model

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

MIB Views

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

Access Policy

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

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

IP Precedence and DSCP Support for SNMP

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

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

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

How to Implement SNMP on Cisco IOS XR Software

This section describes how to implement SNMP.

The **snmp-server** commands enable SNMP on Management Ethernet interfaces by default. For information on how to enable SNMP server support on other inband interfaces, see the *Implementing Management Plane Protection on Cisco IOS XR Software* module in *System Security Configuration Guide for Cisco NCS 6000 Series Routers*.

Configuring SNMPv3

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

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

SUMMARY STEPS

1. **configure**
2. **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

	Command or Action	Purpose
Step 1	**configure**	
Step 2	**snmp-server view** *view-name oid-tree* {**included**	**excluded**} **Example:** `RP/0/RP0/CPU0:router(config)# snmp-server view view_name 1.3.6.1.2.1.1.5 included`	Creates or modifies a view record.
Step 3	**snmp-server group** *name* {**v1**	**v2c**	**v3** {**auth**	**noauth**	**priv**}} [**read** *view*] [**write** *view*] [**notify** *view*] [*access-list-name*] **Example:** `RP/0/RP0/CPU0:router(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 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*] **Example:** `RP/0/RP0/CPU0:router(config)# snmp-server user noauthuser 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.
Step 5	**commit**	

Configuring SNMP Trap Notifications

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

Note You can omit Step 3, on page 70 if you have already completed the steps documented under the Configuring SNMPv3, on page 69 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

	Command or Action	Purpose
Step 1	**configure**	
Step 2	**snmp-server group** *name* {**v1** | **v2c** | **v3** {**auth** | **noauth** | **priv**}} [**read** *view*] [**write** *view*] [**notify** *view*] [*access-list-name*] **Example:** `RP/0/RP0/CPU0:router(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:** `RP/0/RP0/CPU0:router(config)# snmp-server user noauthuser 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.

	Command or Action	Purpose
Step 4	**snmp-server host** *address* [**traps**] [**version** {**1** | **2c** | **3** [**auth** | **noauth** | **priv**]}] *community-string* [**udp-port** *port*] [*notification-type*] **Example:** `RP/0/RP0/CPU0:router(config)# snmp-server host 12.26.25.61 traps version 3 noauth userV3noauth`	Specifies SNMP trap notifications, the version of SNMP to use, the security level of the notifications, and the recipient (host) of the notifications.
Step 5	**snmp-server traps** [*notification-type*] **Example:** `RP/0/RP0/CPU0:router(config)# snmp-server traps bgp`	Enables the sending of trap notifications and specifies the type of trap notifications to be sent. • If a trap is not specified with the *notification-type* argument, all supported trap notifications are enabled on the router. To display which trap notifications are available on your router, enter the **snmp-server traps ?** command.
Step 6	**commit**	
Step 7	**show snmp host** **Example:** `RP/0/RP0/CPU0:router# show snmp host`	(Optional) Displays information about the configured SNMP notification recipient (host), port number, and security model.

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

	Command or Action	Purpose
Step 1	**configure**	
Step 2	**snmp-server contact** *system-contact-string* **Example:** `RP/0/RP0/CPU0:router(config)# snmp-server contact Dial System Operator at beeper # 27345`	(Optional) Sets the system contact string.
Step 3	**snmp-server location** *system-location* **Example:** `RP/0/RP0/CPU0:router(config)# snmp-server location Building 3/Room 214`	(Optional) Sets the system location string.
Step 4	**snmp-server chassis-id** *serial-number* **Example:** `RP/0/RP0/CPU0:router(config)# snmp-server chassis-id 1234456`	(Optional) Sets the system serial number.
Step 5	**commit**	

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

	Command or Action	Purpose
Step 1	**configure**	

	Command or Action	Purpose
Step 2	**snmp-server packetsize** *byte-count* **Example:** `RP/0/RP0/CPU0:router(config)# snmp-server packetsize 1024`	(Optional) Sets the maximum packet size.
Step 3	**commit**	

Changing Notification Operation Values

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

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

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

SUMMARY STEPS

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

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure**	
Step 2	**snmp-server trap-source** *type interface-path-id* **Example:** `RP/0/RP0/CPU0:router(config)# snmp-server trap-source POS 0/0/1/0`	(Optional) Specifies a source interface for trap notifications.

	Command or Action	Purpose
Step 3	**snmp-server queue-length** *length* **Example:** `RP/0/RP0/CPU0:router(config)# snmp-server queue-length 20`	(Optional) Establishes the message queue length for each notification.
Step 4	**snmp-server trap-timeout** *seconds* **Example:** `RP/0/RP0/CPU0:router(config)# snmp-server trap-timeout 20`	(Optional) Defines how often to resend notifications on the retransmission queue.
Step 5	**commit**	

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

	Command or Action	Purpose
Step 1	**configure**	
Step 2	Use one of the following commands: • **snmp-server ipv4 precedence** *value* • **snmp-server ipv4 dscp** *value*	Configures an IP precedence or IP DSCP value for SNMP traffic.

	Command or Action	Purpose
	Example: `RP/0/RP0/CPU0:router(config)# snmp-server dscp 24`	
Step 3	**commit**	

Configuring MIB Data to be Persistent

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

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

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

SUMMARY STEPS

1. (Optional) **snmp-server entityindex persist**
2. (Optional) **snmp-server mibs cbqosmib persist**
3. (Optional) **snmp-server cbqosmib cache refresh time** *time*
4. (Optional) **snmp-server cbqosmib cache service-policy count** *count*
5. **snmp-server ifindex persist**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**snmp-server entityindex persist** **Example:** `RP/0/RP0/CPU0:router(config)# snmp-server entityindex persist`	(Optional) Enables the persistent storage of ENTITY-MIB data.

	Command or Action	Purpose
Step 2	**snmp-server mibs cbqosmib persist** **Example:** `RP/0/RP0/CPU0:router(config)# snmp-server mibs cbqosmib persist`	(Optional) Enables persistent storage of the CISCO-CLASS-BASED-QOS-MIB data.
Step 3	**snmp-server cbqosmib cache refresh time** *time* **Example:** `RP/0/RP0/CPU0:router(config)# snmp-server mibs cbqosmib cache refresh time 45`	(Optional) Enables QoS MIB caching with a specified cache refresh time.
Step 4	**snmp-server cbqosmib cache service-policy count** *count* **Example:** `RP/0/RP0/CPU0:router(config)# snmp-server mibs cbqosmib cache service-policy count 50`	(Optional) Enables QoS MIB caching with a limited number of service policies to cache.
Step 5	**snmp-server ifindex persist** **Example:** `RP/0/RP0/CPU0:router(config)# snmp-server ifindex persist`	Enables ifIndex persistence globally on all Simple Network Management Protocol (SNMP) interfaces.

Configuring LinkUp and LinkDown Traps for a Subset of Interfaces

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

Before You Begin

SNMP must be configured.

SUMMARY STEPS

1. **configure**
2. **snmp-server interface subset** *subset-number* **regular-expression** *expression*
3. **notification linkupdown disable**
4. **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

	Command or Action	Purpose
Step 1	**configure**	
Step 2	**snmp-server interface subset** *subset-number* **regular-expression** *expression* **Example:** `RP/0/RP0/CPU0:router(config)# snmp-server interface subset 10 regular-expression "^Gig[a-zA-Z]+[0-9/]+\." RP/0/RP0/CPU0:router(config-snmp-if-subset)#`	Enters snmp-server interface mode for the interfaces identified by the regular expression. The subset-number argument identifies the set of interfaces, and also assigns a priority to the subset in the event that an interface is included in more than one subset. Lower numbers have higher priority and their configuration takes precedent over interface subsets with higher numbers. The *expression* argument must be entered surrounded by double quotes. Refer to the *Understanding Regular Expressions, Special Characters, and Patterns* module in for more information regarding regular expressions.
Step 3	**notification linkupdown disable** **Example:** `RP/0/RP0/CPU0:router(config-snmp-if-subset)# notification linkupdown disable`	Disables linkUp and linkDown traps for all interfaces being configured. To enable previously disabled interfaces, use the **no** form of this command.
Step 4	**commit**	
Step 5	**show snmp interface notification subset** *subset-number* **Example:** `RP/0/RP0/CPU0:router# show snmp interface notification subset 10`	(Optional) Displays the linkUp and linkDown notification status for all interfaces identified by the subset priority.
Step 6	**show snmp interface notification regular-expression** *expression* **Example:** `RP/0/RP0/CPU0:router# show snmp interface notification regular-expression "^Gig[a-zA-Z]+[0-9/]+\."`	(Optional) Displays the linkUp and linkDown notification status for all interfaces identified by the regular expression.
Step 7	**show snmp interface notification** *type interface-path-id* **Example:** `RP/0/RP0/CPU0:router# show snmp interface notification tengige 0/4/0/3.10`	(Optional) Displays the linkUp and linkDown notification status for the specified interface.

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 00:00:00:09:00:00:00:a1:61:6c:20:61
```

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

Verifying the Identification of the Local SNMP Engines

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

```
config
  show snmp engineid

  SNMP engineID 00000009000000a1ffffffff
```

Creating a View

There are two ways to create a view:

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

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

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

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

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

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

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

Verifying Configured Views

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

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

  v1default 1.3.6.1 - included nonVolatile active
  SNMP_VIEW1 1.3.6.1.2.1.1 - included nonVolatile active
  SNMP_VIEW1 1.3.6.1.2.1.1.5 - excluded nonVolatile active
```

Creating Groups

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

```
RP/0/RP0/CPU0:router(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_name1 v3 auth read view_name1 write view_name2
  !
```

Verifying Groups

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

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

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

Creating and Verifying Users

Given the following SNMPv3 view and SNMPv3 group configuration:

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

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

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

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

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>
snmp-server user username  nervectrgrp remote 10.69.236.147 udp-port 162 v3 auth sha
<password> priv aes 128 <password>
RP/0/RP0/CPU0:router# show run snmp-server user

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

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

:

```
snmp-server user username1  nervectrgrp remote 10.69.236.146 udp-port 162 v3 auth sha
<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>
snmp-server user username3  nervectrgrp remote 10.69.236.147 udp-port 162 v3 auth sha
<password> priv aes 128 <password>
RP/0/RP0/CPU0:router# show run snmp-server 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 10.69.236.147 udp-port 162 v3 auth sha
encrypted <password> priv aes 128 encrypted <password>
```

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

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

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

Given the following SNMPv3 view and SNMPv3 group configuration:

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

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

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

Given the following SNMPv3 view and SNMPv3 group configuration:

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

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

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

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

Given the following SNMPv3 view and SNMPv3 group configuration:

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

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

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

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

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

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

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

Configuring Trap Notifications: Example

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

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

```
!
  snmp-server host 10.50.32.170 version 2c 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 view view_name 1.3 included
  snmp-server community public RW
  snmp-server group groupv2c v2c read view_name
  snmp-server group groupV3auth v3 auth read view_name
  snmp-server group groupV3priv v3 priv read view_name
  snmp-server group groupV3noauth v3 noauth read view_name
  !
```

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

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

```
config
  show snmp host

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

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

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

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

Setting an IP Precedence Value for SNMP Traffic: Example

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

```
configure
  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

Related Topic	Document Title
Cisco IOS XR SNMP commands	*SNMP Server Commands on* module of *System Management Command Reference for Cisco NCS 6000 Series Routers*
MIB information	
Cisco IOS XR commands	
Getting started with Cisco IOS XR software	
Information about user groups and task IDs	*Configuring AAA Services on* module of *System Security Configuration Guide for Cisco NCS 6000 Series Routers*
Cisco IOS XR Quality of Service	*Modular Quality of Service Configuration Guide for Cisco NCS 6000 Series Routers*

Standards

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

MIBs

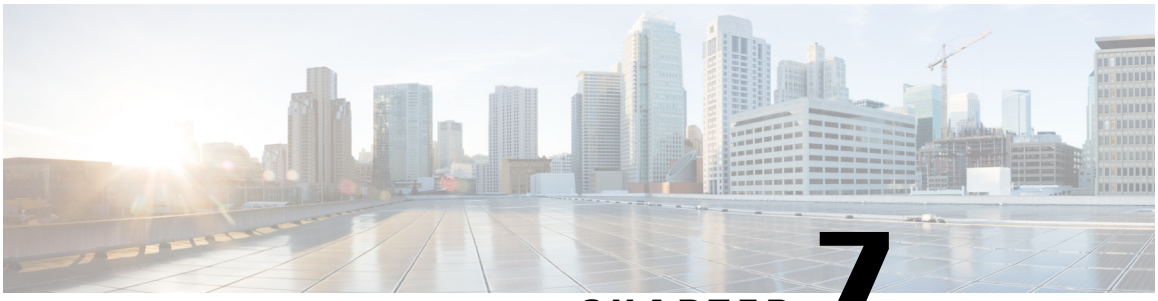
MIBs	MIBs Link
—	To locate and download MIBs using Cisco IOS XR software, use the Cisco MIB Locator found at the following URL and choose a platform under the Cisco Access Products menu: http://cisco.com/public/sw-center/netmgmt/cmtk/mibs.shtml

RFCs

RFCs	Title
RFC 3411	*An Architecture for Describing Simple Network Management Protocol (SNMP) Management Frameworks*
RFC 3412	*Message Processing and Dispatching for the Simple Network Management Protocol (SNMP)*
RFC 3413	*Simple Network Management Protocol (SNMP) Applications*
RFC 3414	*User-based Security Model (USM) for version 3 of the Simple Network Management Protocol (SNMPv3)*
RFC 3415	*View-based Access Control Model (VACM) for the Simple Network Management Protocol (SNMP)*
RFC 3416	*Version 2 of the Protocol Operations for the Simple Network Management Protocol (SNMP)*
RFC 3417	*Transport Mappings for the Simple Network Management Protocol (SNMP)*
RFC 3418	*Management Information Base (MIB) for the Simple Network Management Protocol (SNMP)*

Technical Assistance

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



CHAPTER 7

Configuring 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 11: Feature History for Periodic MIB Data Collection and Transfer

Release	Modification
Release 4.2.0	The periodic MIB data collection and transfer feature was introduced and supported the IF-MIB only.
Release 4.2.1	Additional MIBs were supported.

This module contains the following topics:

Prerequisites for Periodic MIB Data Collection and Transfer

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

Information About Periodic MIB Data Collection and Transfer

SNMP Objects and Instances

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

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

Bulk Statistics Object Lists

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

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

Bulk Statistics Schemas

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

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

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

Bulk Statistics Transfer Options

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

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

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

Benefits of Periodic MIB Data Collection and Transfer

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

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

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

How to Configure Periodic MIB Data Collection and Transfer

Configuring a Bulk Statistics Object List

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

SUMMARY STEPS

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

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure**	
Step 2	**snmp-server mib bulkstat object-list** *list-name* **Example:** `snmp-server mib bulkstat object-list ifMib`	Defines an SNMP bulk statistics object list and enters bulk statistics object list configuration mode.

	Command or Action	Purpose

Step 3	**add** {**oid** | *object-name*}
	
	Example:
	
	`RP/0/RP0/CPU0:router(config-bulk-objects)# add 1.3.6.1.2.1.2.2.1.11`
	`RP/0/RP0/CPU0:router(config-bulk-objects)# add ifAdminStatus`
	`RP/0/RP0/CPU0:router(config-bulk-objects)# add ifDescr`
		Adds a MIB object to the bulk statistics object list. Repeat as desired until all objects to be monitored in this list are added.
		
		Note All the objects in a bulk statistics object list have to be indexed by the same MIB index. However, the objects in the object list do not need to belong to the same MIB or MIB table.
		
		When specifying an object name instead of an OID (using the add command), only object names with mappings shown in the **show snmp mib object** command output can be used.

Step 4	**commit**	

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

	Command or Action	Purpose
Step 1	**configure**	

Step 2	**snmp-server mib bulkstat schema** *schema-name*
	
	Example:
	`RP/0/RP0/CPU0:router(config)# snmp-server mib`
	`bulkstat schema intE0`
	`RP/0/RP0/CPU0:router(config-bulk-sc)#`
		Names the bulk statistics schema and enters bulk statistics schema mode.

Step 3	**object-list** *list-name* **Example:** `RP/0/RP0/CPU0:router(config-bulk-sc)# object-list ifMib`	Specifies the bulk statistics object list to be included in this schema. Specify only one object list per schema. If multiple object-list commands are executed, the earlier ones are overwritten by newer commands.

Step 4	Do one of the following:
	• **instance exact** {**interface** *interface-id* [**sub-if**] | **oid** *oid*}
	• **instance wild** {**interface** *interface-id* [**sub-if**] | **oid** *oid*}
	• **instance range start** *oid* **end** *oid*
	• **instance repetition** *oid* **max** *repeat-number*
	
	Example:
	`RP/0/RP0/CPU0:router(config-bulk-sc)# instance wild oid 1`
	or
	`RP/0/RP0/CPU0:router(config-bulk-sc)# instance exact interface FastEthernet 0/1.25`
	or
	`RP/0/RP0/CPU0:router(config-bulk-sc)# instance range start 1 end 2`
	or
	`RP/0/RP0/CPU0:router(config-bulk-sc)# instance repetition 1 max 4`
		Specifies the instance information for objects in this schema:
		• The **instance exact** command indicates that the specified instance, when appended to the object list, represents the complete OID.
		• The **instance wild** command indicates that all subindices of the specified OID belong to this schema. The wild keyword allows you to specify a partial, “wild carded” instance.
		• The **instance range** command indicates a range of instances on which to collect data.
		• The **instance repetition** command indicates data collection to repeat for a certain number of instances of a MIB object.
		
		Note Only one **instance** command can be configured per schema. If multiple **instance** commands are executed, the earlier ones are overwritten by new commands.

Step 5	**poll-interval** *minutes* **Example:** `RP/0/RP0/CPU0:router(config-bulk-sc)# poll-interval 10`	Sets how often data should be collected from the object instances specified in this schema, in minutes. The default is once every 5 minutes. The valid range is from 1 to 20000.
Step 6	**commit**	

What to Do Next

Configure the bulk statistics transfer options.

Configuring Bulk Statistics Transfer Options

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

Before You Begin

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

SUMMARY STEPS

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

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure**	

Step 2	**snmp-server mib bulkstat transfer-id** *transfer-id*
	
	Example:
	`RP/0/RP0/CPU0:router(config)# snmp-server mib`
	`bulkstat transfer bulkstat1`
		Identifies the transfer configuration with a name (*transfer-id* argument) and enters bulk statistics transfer configuration mode.

	Command or Action	Purpose
Step 3	**buffer-size** *bytes* **Example:** `RP/0/RP0/CPU0:router(config-bulk-tr)# buffersize 3072`	(Optional) Specifies the maximum size for the bulk statistics data file, in bytes. The valid range is from 1024 to 2147483647 bytes. The default buffer size is 2048 bytes. **Note** If the maximum buffer size for a bulk statistics file is reached before the transfer interval time expires, all additional data received is deleted. To correct this behavior, you can decrease the polling frequency, or increase the size of the bulk statistics buffer.
Step 4	**format** {**bulkBinary** | **bulkASCII** | **schemaASCII**} **Example:** `RP/0/RP0/CPU0:router(config-bulk-tr)# format schemaASCII`	(Optional) Specifies the format of the bulk statistics data file (VFile). The default is schemaASCII. **Note** Transfers can only be performed using schemaASCII (cdcSchemaASCII) format. SchemaASCII is a human-readable format that contains parser-friendly hints for parsing data values.

Step 5	**schema** *schema-name*
	
	Example:
	
	`RP/0/RP0/CPU0:router(config-bulk-tr)# schema ATM2/0-IFMIB`
	`RP/0/RP0/CPU0:router(config-bulk-tr)# schema ATM2/0-CAR`
	`RP/0/RP0/CPU0:router(config-bulk-tr)# schema Ethernet2/1-IFMIB`
		Specifies the bulk statistics schema to be transferred. Repeat this command as desired. Multiple schemas can be associated with a single transfer configuration; all collected data are placed in a single bulk data file (VFile).

Step 6	**transfer-interval** *minutes* **Example:** RP/0/RP0/CPU0:router `RP/0/RP0/CPU0:router(config-bulk-tr)# transfer-interval 20`	(Optional) Specifies how often the bulk statistics file are transferred, in minutes. The default value is once every 30 minutes. The transfer interval is the same as the collection interval.
Step 7	**url primary** *url* **Example:** `RP/0/RP0/CPU0:router(config-bulk-tr)# url primary ftp://user:password@host/folder/bulkstat1`	Specifies the network management system (host) that the bulk statistics data file is transferred to, and the protocol to use for transfer. The destination is specified as a Uniform Resource Locator (URL). FTP or TFTP can be used for the bulk statistics file transfer.
Step 8	**url secondary** *url* **Example:** `RP/0/RP0/CPU0:router(config-bulk-tr)# url secondary tftp://10.1.0.1/tftpboot/user/bulkstat1`	(Optional) Specifies a backup transfer destination and protocol for use in the event that transfer to the primary location fails. FTP or TFTP can be used for the bulk statistics file transfer.
Step 9	**retry** *number* **Example:** `RP/0/RP0/CPU0:router(config-bulk-tr)# retry 1`	(Optional) Specifies the number of transmission retries. The default value is 0 (in other words, no retries). If an attempt to send the bulk statistics file fails, the system can be configured to attempt to send the file again using this command.

	Command or Action	Purpose
		One retry includes an attempt first to the primary destination then, if the transmission fails, to the secondary location. For example, if the retry value is 1, an attempt is made first to the primary URL, then to the secondary URL, then to the primary URL again, then to the secondary URL again. The valid range is from 0 to 100. If all retries fail, the next normal transfer occurs after the configured transfer-interval time.
Step 10	**retain** *minutes* **Example:** `RP/0/RP0/CPU0:router(config-bulk-tr)# retain 60`	(Optional) Specifies how long the bulk statistics file should be kept in system memory, in minutes, after the completion of the collection interval and a transmission attempt is made. The default value is 0. Zero (0) indicates that the file is deleted immediately after the transfer is attempted. The valid range is from 0 to 20000. **Note** If the retry command is used, you should configure a retain interval larger than 0. The interval between retries is the retain interval divided by the retry number. For example, if **retain 10** and **retry 2** are configured, two retries are attempted once every 5 minutes. Therefore, if retain 0 is configured, no retries are attempted.
Step 11	**enable** **Example:** `RP/0/RP0/CPU0:router(config-bulk-tr)# enable`	Begins the bulk statistics data collection and transfer process for this configuration. • For successful execution of this action, at least one schema with non-zero number of objects must be configured. • Periodic collection and file transfer begins only if this command is configured. Conversely, the **no enable** command stops the collection process. A subsequent **enable** starts the operations again. • Each time the collection process is started using the **enable** command, data is collected into a new bulk statistics file. When the **no enable** command is used, the transfer process for any collected data immediately begins (in other words, the existing bulk statistics file is transferred to the specified management station).
Step 12	**commit**	

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

	Command or Action	Purpose
Step 1	**show snmp mib bulkstat transfer** *transfer-name*	(Optional) The show command for this feature lists all bulk statistics virtual files (VFiles) on the system that have finished collecting data. (Data files that are not complete are not displayed.) The output lists all of the completed local bulk statistics files, the remaining time left before the bulk statistics file is deleted (remaining retention period), and the state of the bulk statistics file. The "STATE" of the bulk statistics file is one of the following: • Queued--Indicates that the data collection for this bulk statistics file is completed (in other words, the transfer interval has been met) and that the bulk statistics file is waiting for transfer to the configured destination(s). • Retry--Indicates that one or more transfer attempts have failed and that the file transfer will be attempted again. The number of retry attempts remaining are displayed in parenthesis. • Retained--Indicates that the bulk statistics file has either been successfully transmitted or that the configured number of retries have been completed. 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/RP0/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)
```

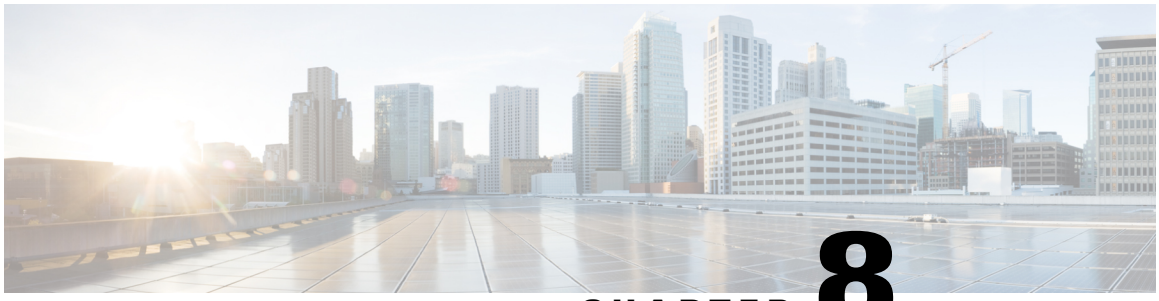
Periodic MIB Data Collection and Transfer: Example

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
url primary tftp://223.255.254.254/auto/tftp-sjc-users3/dseeniva/dumpdcm
schema cempWild
schema cempRepeat
transfer-interval 2
!
```

This example shows sample bulk statistics file content:

```
Schema-def cempt1.cempWild "%u, %s, %s, %d" Epochtime instanceoid
            1.3.6.1.4.1.9.9.221.1.1.1.1.3 1.3.6.1.4.1.9.9.221.1.1.1.1.2
cempt1.cempWild: 1339491515, 8695772.1, processor, 2
cempt1.cempWild: 1339491515, 8695772.2, reserved, 11
cempt1.cempWild: 1339491515, 8695772.3, image, 12
cempt1.cempWild: 1339491575, 8695772.1, processor, 2
cempt1.cempWild: 1339491575, 8695772.2, reserved, 11
cempt1.cempWild: 1339491575, 8695772.3, image, 12
Schema-def cempt1.cempRepeat "%u, %s, %s, %d" Epochtime instanceoid
            1.3.6.1.4.1.9.9.221.1.1.1.1.3 1.3.6.1.4.1.9.9.221.1.1.1.1.2
cempt1.cempRepeat: 1339491515, 8695772.1, processor, 2
cempt1.cempRepeat: 1339491515, 8695772.2, reserved, 11
cempt1.cempRepeat: 1339491515, 8695772.3, image, 12
cempt1.cempRepeat: 1339491515, 26932192.1, processor, 2
cempt1.cempRepeat: 1339491515, 26932192.2, reserved, 11
cempt1.cempRepeat: 1339491515, 26932192.3, image, 12
cempt1.cempRepeat: 1339491515, 35271015.1, processor, 2
cempt1.cempRepeat: 1339491515, 35271015.2, reserved, 11
cempt1.cempRepeat: 1339491515, 35271015.3, image, 12
cempt1.cempRepeat: 1339491515, 36631989.1, processor, 2
cempt1.cempRepeat: 1339491515, 36631989.2, reserved, 11
cempt1.cempRepeat: 1339491515, 36631989.3, image, 12
cempt1.cempRepeat: 1339491515, 52690955.1, processor, 2
cempt1.cempRepeat: 1339491515, 52690955.2, reserved, 11
cempt1.cempRepeat: 1339491515, 52690955.3, image, 12
```



CHAPTER 8

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 104. To locate documentation for other commands that might appear in the course of running a configuration task, search online in .

Table 12: Feature History for Implementing CDP on Cisco IOS XR Software

Release	Modification
Release 5.0.0	This feature was introduced.

This module contains the following topics:

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 13: Type-Length-Value Definitions for CDPv2, on page 98 summarizes the TLV definitions for CDP advertisements.

Table 13: Type-Length-Value Definitions for CDPv2

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

TLV	Definition
VTP Management Domain TLV	Advertises the system's configured VTP management domain name-string. Used by network operators to verify VTP domain configuration in adjacent network nodes.
Native VLAN TLV	Indicates, per interface, the assumed VLAN for untagged packets on the interface. CDP learns the native VLAN for an interface. This feature is implemented only for interfaces that support the IEEE 802.1Q protocol.
Full/Half Duplex TLV	Indicates status (duplex configuration) of CDP broadcast interface. Used by network operators to diagnose connectivity problems between adjacent network elements.

How to Implement CDP on Cisco IOS XR Software

Enabling CDP

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

SUMMARY STEPS

1. **configure**
2. **cdp**
3. **interface** *type interface-path-id*
4. **cdp**
5. **commit**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure**	
Step 2	**cdp** **Example:** `RP/0/RP0/CPU0:router(config)# cdp`	Enables CDP globally.
Step 3	**interface** *type interface-path-id* **Example:** `RP/0/RP0/CPU0:router(config)# interface pos 0/0/0/1`	Enters interface configuration mode.

	Command or Action	Purpose
Step 4	**cdp** **Example:** `RP/0/RP0/CPU0:router(config-if)# cdp`	Enables CDP on an interface.
Step 5	**commit**	

Modifying CDP Default Settings

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

Note The commands can be entered in any order.

SUMMARY STEPS

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

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure**	
Step 2	**cdp advertise v1** **Example:** `RP/0/RP0/CPU0:router(config)# cdp advertise v1`	Configures CDP to use only version 1 (CDPv1) in communicating with neighboring devices. • By default, when CDP is enabled, the router sends CDPv2 packets. CDP also sends and receives CDPv1 packets if the device with which CDP is interacting does not process CDPv2 packets. • In this example, the router is configured to send and receive only CDPv1 packets.

	Command or Action	Purpose
Step 3	**cdp holdtime** *seconds* **Example:** `RP/0/RP0/CPU0:router(config)# cdp holdtime 30`	Specifies the amount of time that the receiving networking device will hold a CDP packet sent from the router before discarding it. • By default, when CDP is enabled, the receiving networking device holds a CDP packet for 180 seconds before discarding it. **Note** The CDP hold time must be set to a higher number of seconds than the time between CDP transmissions, which is set with the **cdp timer** command. • In this example, the value of hold-time for the *seconds* argument is set to 30.
Step 4	**cdp timer** *seconds* **Example:** `RP/0/RP0/CPU0:router(config)# cdp timer 20`	Specifies the frequency at which CDP update packets are sent. • By default, when CDP is enabled, CDP update packets are sent at a frequency of once every 60 seconds. **Note** A lower timer setting causes CDP updates to be sent more frequently. • In this example, CDP update packets are configured to be sent at a frequency of once every 20 seconds.
Step 5	**commit**	
Step 6	**show cdp** **Example:** `RP/0/RP0/CPU0:router# show cdp`	(Optional) Displays global CDP information. The output displays the CDP version running on the router, the hold time setting, and the timer setting.

Monitoring CDP

This task shows how to monitor CDP.

Note The commands can be entered in any order.

SUMMARY STEPS

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

DETAILED STEPS

	Command or Action	Purpose
Step 1	**show cdp entry** {***** | *entry-name*} [**protocol** | **version**] **Example:** `RP/0/RSP0/CPU0:router# show cdp entry *`	Displays information about a specific neighboring device or all neighboring devices discovered using CDP.
Step 2	**show cdp interface** [*type interface-path-id* | **location** *node-id*] **Example:** `RP/0/RSP0/CPU0:router# show cdp interface pos 0/0/0/1`	Displays information about the interfaces on which CDP is enabled.
Step 3	**show cdp neighbors** [*type interface-path-id* | **location** *node-id*] [**detail**] **Example:** `RP/0/RSP0/CPU0:router# show cdp neighbors`	Displays detailed information about neighboring devices discovered using CDP.
Step 4	**show cdp traffic** [**location** *node-id*] **Example:** `RP/0/RSP0/CPU0:router# show cdp traffic`	Displays information about the traffic gathered between devices using CDP.

Examples

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

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

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

  Device ID        Local Intrfce   Holdtme  Capability  Platform  Port ID
  router1          Mg0/0/CPU0/0    177      T S         WS-C2924M Fa0/12
  router2          PO0/4/0/0       157      R           12008/GRP PO0/4/0/1
```

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

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

  -------------------------
  Device ID: uut-user
  SysName : uut-user
  Entry address(es):
  IPv4 address: 1.1.1.1
  IPv6 address: 1::1
  IPv6 address: 2::2
```

```
  Platform: cisco 12008/GRP, Capabilities: Router
  Interface: POS0/4/0/3
  Port ID (outgoing port): POS0/2/0/3
  Holdtime : 177 sec

  Version :
  Cisco IOS XR Software, Version 0.0.0[Default]
  Copyright (c) 2005 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/RP0/CPU0:router# show cdp entry router2

  advertisement version: 2

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

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

  advertisement version: 2
```

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

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

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

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

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

  CDP counters :
          Packets output: 194, Input: 99
          Hdr syntax: 0, Chksum error: 0, Encaps failed: 0
          No memory: 0, Invalid packet: 0, Truncated: 0
          CDP version 1 advertisements output: 0, Input: 0
          CDP version 2 advertisements output: 194, Input: 99
          Unrecognize Hdr version: 0, File open failed: 0
```

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

```
RP/0/RP0/CPU0: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 1 advertisements output: 0, Input: 0
```

```
CDP version 2 advertisements output: 16, Input: 13
Unrecognize Hdr version: 0, File open failed: 0
```

Configuration Examples for Implementing CDP

Enabling CDP: Example

The following example shows how to configure CDP globally and then enable CDP on 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/RP0/CPU0:router# show cdp

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

Additional References

The following sections provide references related to implementing CDP on Cisco IOS XR software.

Related Documents

Related Topic	Document Title
Cisco IOS XR CDP commands	*CDP Commands on Cisco IOS XR Software* module of *System Management Command Reference for Cisco NCS 6000 Series Routers*
Cisco IOS XR commands	
Getting started with Cisco IOS XR Software	

Related Topic	Document Title
Information about user groups and task IDs	*Configuring AAA Services on Cisco IOS XR Software* module of *System Security Configuration Guide for Cisco NCS 6000 Series Routers*

Standards

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

MIBs

MIBs	MIBs Link
—	To locate and download MIBs using Cisco IOS XR software, use the Cisco MIB Locator found at the following URL and choose a platform under the Cisco Access Products menu: http://cisco.com/public/sw-center/netmgmt/cmtk/mibs.shtml

RFCs

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

Technical Assistance

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