Network Management Configuration Guide, Cisco IOS XE Fuji 16.9.x (Catalyst 9200 Switches)

First Published: 2018-11-30

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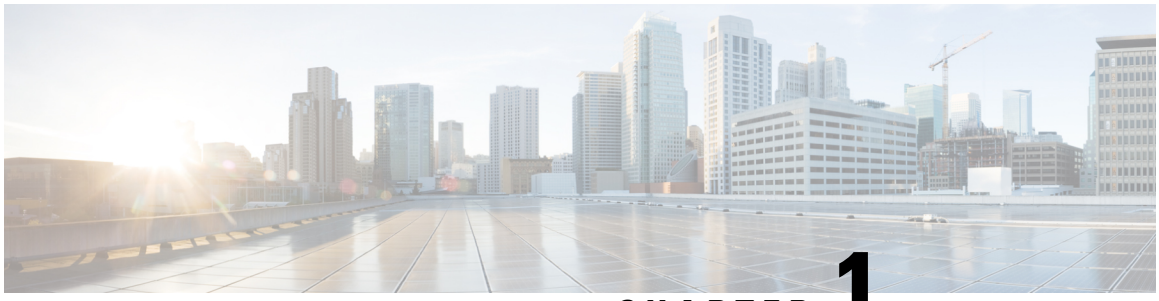


CHAPTER 1

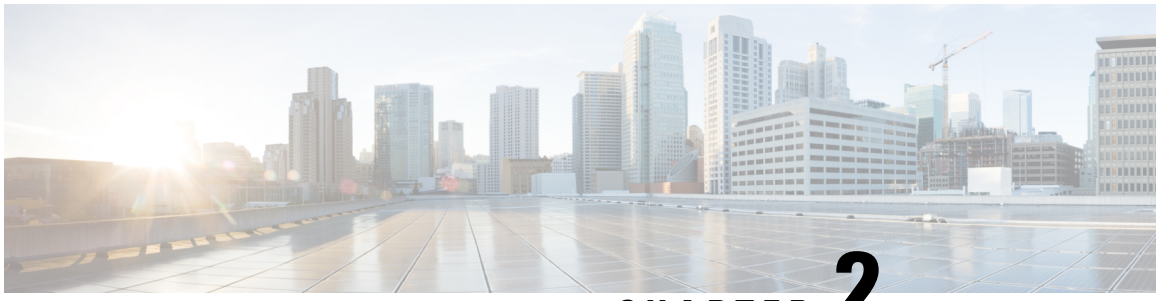
Configuring Cisco Plug and Play

Configuring Cisco Plug and Play

For information about configuring Plug and Play, see

- Cisco Plug and Play Feature Guide
- Configuration Guide for Cisco Network Plug and Play on APIC-EM

Configuring Cisco Plug and Play



CHAPTER 2

Configuring the Cisco Discovery Protocol

Cisco Discovery Protocol is a Layer 2, media-independent, and network-independent protocol that runs on Cisco devices and enables networking applications to learn about directly connected devices nearby. This protocol facilitates the management of Cisco devices by discovering these devices, determining how they are configured, and allowing systems using different network-layer protocols to learn about each other.

This module describes Cisco Discovery Protocol Version 2 and how it functions with SNMP.

Information About Cisco Discovery Protocol

Cisco Discovery Protocol Overview

Cisco Discovery Protocol is a device discovery protocol that runs over Layer 2 (the data-link layer) on all Cisco-manufactured devices (routers, bridges, access servers, controllers, and switches) and allows network management applications to discover Cisco devices that are neighbors of already known devices. With Cisco Discovery Protocol, network management applications can learn the device type and the SNMP agent address of neighboring devices running lower-layer, transparent protocols. This feature enables applications to send SNMP queries to neighboring devices.

Cisco Discovery Protocol runs on all media that support Subnetwork Access Protocol (SNAP). Because Cisco Discovery Protocol runs over the data-link layer only, two systems that support different network-layer protocols can learn about each other.

Each Cisco Discovery Protocol-configured device sends periodic messages to a multicast address, advertising at least one address at which it can receive SNMP messages. The advertisements also contain time-to-live, or holdtime information, which is the length of time a receiving device holds Cisco Discovery Protocol information before discarding it. Each device also listens to the messages sent by other devices to learn about neighboring devices.

On the device, Cisco Discovery Protocol enables Network Assistant to display a graphical view of the network. The device uses Cisco Discovery Protocol to find cluster candidates and maintain information about cluster members and other devices up to three cluster-enabled devices away from the command device by default.

- Cisco Discovery Protocol identifies connected endpoints that communicate directly with the device.

- To prevent duplicate reports of neighboring devices, only one wired device reports the location information.
- The wired device and the endpoints both send and receive location information.

Default Cisco Discovery Protocol Configuration

This table shows the default Cisco Discovery Protocol configuration.

Feature	Default Setting
Cisco Discovery Protocol global state	Enabled
Cisco Discovery Protocol interface state	Enabled
Cisco Discovery Protocol timer (packet update frequency)	60 seconds
Cisco Discovery Protocol holdtime (before discarding)	180 seconds
Cisco Discovery Protocol Version-2 advertisements	Enabled

How to Configure Cisco Discovery Protocol

Configuring Cisco Discovery Protocol Characteristics

You can configure these Cisco Discovery Protocol characteristics:

- Frequency of Cisco Discovery Protocol updates
- Amount of time to hold the information before discarding it
- Whether or not to send Version 2 advertisements

Note Steps 3 through 5 are all optional and can be performed in any order.

Follow these steps to configure the Cisco Discovery Protocol characteristics.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **cdp timer** *seconds*
4. **cdp holdtime** *seconds*
5. **cdp advertise-v2**
6. **end**
7. **show running-config**
8. **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**cdp timer** *seconds* **Example:** `Device(config)# cdp timer 20`	(Optional) Sets the transmission frequency of Cisco Discovery Protocol updates in seconds. The range is 5 to 254; the default is 60 seconds.
Step 4	**cdp holdtime** *seconds* **Example:** `Device(config)# cdp holdtime 60`	(Optional) Specifies the amount of time a receiving device should hold the information sent by your device before discarding it. The range is 10 to 255 seconds; the default is 180 seconds.
Step 5	**cdp advertise-v2** **Example:** `Device(config)# cdp advertise-v2`	(Optional) Configures Cisco Discovery Protocol to send Version 2 advertisements. This is the default state.
Step 6	**end** **Example:** `Device(config)# end`	Returns to privileged EXEC mode.
Step 7	**show running-config** **Example:** `Device# show running-config`	Verifies your entries.
Step 8	**copy running-config startup-config** **Example:** `Device# copy running-config startup-config`	(Optional) Saves your entries in the configuration file.

What to do next

Use the **no** form of the Cisco Discovery Protocol commands to return to the default settings.

Disabling Cisco Discovery Protocol

Cisco Discovery Protocol is enabled by default.

Note Device clusters and other Cisco devices (such as Cisco IP Phones) regularly exchange Cisco Discovery Protocol messages. Disabling Cisco Discovery Protocol can interrupt cluster discovery and device connectivity.

Follow these steps to disable the Cisco Discovery Protocol device discovery capability.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **no cdp run**
4. **end**
5. **show running-config**
6. **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**no cdp run** **Example:** `Device(config)# no cdp run`	Disables Cisco Discovery Protocol.
Step 4	**end** **Example:** `Device(config)# end`	Returns to privileged EXEC mode.

	Command or Action	Purpose
Step 5	**show running-config** **Example:** `Device# show running-config`	Verifies your entries.
Step 6	**copy running-config startup-config** **Example:** `Device# copy running-config startup-config`	(Optional) Saves your entries in the configuration file.

What to do next

You must reenable Cisco Discovery Protocol to use it.

Enabling Cisco Discovery Protocol

Cisco Discovery Protocol is enabled by default.

Note Device clusters and other Cisco devices (such as Cisco IP Phones) regularly exchange Cisco Discovery Protocol messages. Disabling Cisco Discovery Protocol can interrupt cluster discovery and device connectivity.

Follow these steps to enable Cisco Discovery Protocol when it has been disabled.

Before you begin

Cisco Discovery Protocol must be disabled, or it cannot be enabled.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **cdp run**
4. **end**
5. **show running-config**
6. **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:**	Enables privileged EXEC mode. • Enter your password if prompted.

	Command or Action	Purpose
	`Device> enable`	
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**cdp run** **Example:** `Device(config)# cdp run`	Enables Cisco Discovery Protocol if it has been disabled.
Step 4	**end** **Example:** `Device(config)# end`	Returns to privileged EXEC mode.
Step 5	**show running-config** **Example:** `Device# show running-config`	Verifies your entries.
Step 6	**copy running-config startup-config** **Example:** `Device# copy running-config startup-config`	(Optional) Saves your entries in the configuration file.

What to do next

Use the **show run all** command to show that Cisco Discovery Protocol has been enabled. If you enter only **show run**, the enabling of Cisco Discovery Protocol may not be displayed.

Disabling Cisco Discovery Protocol on an Interface

Cisco Discovery Protocol is enabled by default on all supported interfaces to send and to receive Cisco Discovery Protocol information.

Note Device clusters and other Cisco devices (such as Cisco IP Phones) regularly exchange Cisco Discovery Protocol messages. Disabling Cisco Discovery Protocol can interrupt cluster discovery and device connectivity.

Note Cisco Discovery Protocol bypass is not supported and may cause a port go into err-disabled state.

Follow these steps to disable Cisco Discovery Protocol on a port.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface** *interface-id*
4. **no cdp enable**
5. **end**
6. **show running-config**
7. **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**interface** *interface-id* **Example:** `Device(config)# interface gigabitethernet 1/0/1`	Specifies the interface on which you are disabling Cisco Discovery Protocol, and enters interface configuration mode.
Step 4	**no cdp enable** **Example:** `Device(config-if)# no cdp enable`	Disables Cisco Discovery Protocol on the interface specified in Step 3.
Step 5	**end** **Example:** `Device(config)# end`	Returns to privileged EXEC mode.
Step 6	**show running-config** **Example:**	Verifies your entries.

	Command or Action	Purpose
	`Device# show running-config`	
Step 7	**copy running-config startup-config** **Example:** `Device# copy running-config startup-config`	(Optional) Saves your entries in the configuration file.

Enabling Cisco Discovery Protocol on an Interface

Cisco Discovery Protocol is enabled by default on all supported interfaces to send and to receive Cisco Discovery Protocol information.

Note Device clusters and other Cisco devices (such as Cisco IP Phones) regularly exchange Cisco Discovery Protocol messages. Disabling Cisco Discovery Protocol can interrupt cluster discovery and device connectivity.

Note Cisco Discovery Protocol bypass is not supported and may cause a port go into err-disabled state.

Follow these steps to enable Cisco Discovery Protocol on a port on which it has been disabled.

Before you begin

Cisco Discovery Protocol must be disabled on the port that you are trying to Cisco Discovery Protocol enable on, or it cannot be enabled.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface** *interface-id*
4. **cdp enable**
5. **end**
6. **show running-config**
7. **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:**	Enables privileged EXEC mode. • Enter your password if prompted.

	Command or Action	Purpose
	`Device> enable`	
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**interface** *interface-id* **Example:** `Device(config)# interface gigabitethernet1/0/1`	Specifies the interface on which you are enabling Cisco Discovery Protocol, and enters interface configuration mode.
Step 4	**cdp enable** **Example:** `Device(config-if)# cdp enable`	Enables Cisco Discovery Protocol on a disabled interface.
Step 5	**end** **Example:** `Device(config)# end`	Returns to privileged EXEC mode.
Step 6	**show running-config** **Example:** `Device# show running-config`	Verifies your entries.
Step 7	**copy running-config startup-config** **Example:** `Device# copy running-config startup-config`	(Optional) Saves your entries in the configuration file.

Monitoring and Maintaining Cisco Discovery Protocol

Table 1: Commands for Displaying Cisco Discovery Protocol Information

Command	Description
clear cdp counters	Resets the traffic counters to zero.
clear cdp table	Deletes the Cisco Discovery Protocol table of information about neighbors.

Command	Description
show cdp	Displays global information, such as frequency of transmissions and the holdtime for packets being sent.
show cdp entry *entry-name* [**version**] [**protocol**]	Displays information about a specific neighbor. You can enter an asterisk (*) to display all Cisco Discovery Protocol neighbors, or you can enter the name of the neighbor about which you want information. You can also limit the display to information about the protocols enabled on the specified neighbor or information about the version of software running on the device.
show cdp interface [*interface-id*]	Displays information about interfaces where Cisco Discovery Protocol is enabled. You can limit the display to the interface about which you want information.
show cdp neighbors [*interface-id*] [*detail*]	Displays information about neighbors, including device type, interface type and number, holdtime settings, capabilities, platform, and port ID. You can limit the display to neighbors of a specific interface or expand the display to provide more detailed information.
show cdp traffic	Displays Cisco Discovery Protocol counters, including the number of packets sent and received and checksum errors.

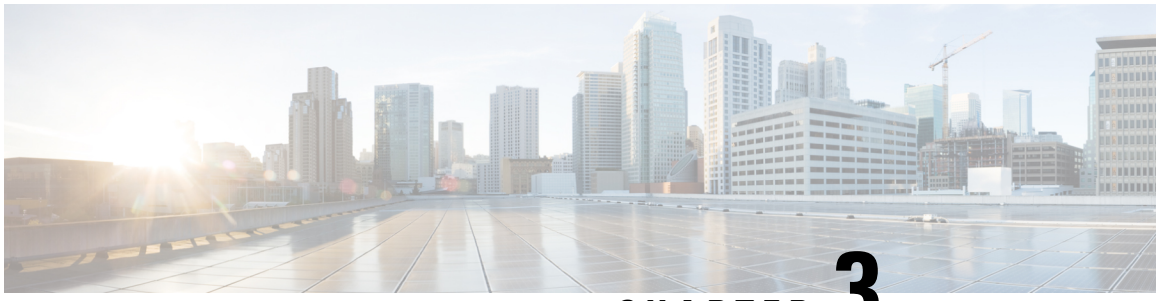
Feature History for Cisco Discovery Protocol

This table provides release and related information for the features explained in this module.

These features are available in all the releases subsequent to the one they were introduced in, unless noted otherwise.

Release	Feature	Feature Information
Cisco IOS XE Fuji 16.9.2	Cisco Discovery Protocol	The feature was introduced. Cisco Discovery Protocol is a Layer 2, media-independent, and network-independent protocol that runs on Cisco devices and enables networking applications to learn about directly connected devices nearby.

Use the Cisco Feature Navigator to find information about platform and software image support. To access Cisco Feature Navigator, go to https://cfnng.cisco.com.



CHAPTER 3

Configuring Cisco Discovery Protocol Bypass

In Cisco Discovery Protocol Bypass mode Cisco Discovery Protocol packets are received and transmitted unchanged. Received packets are not processed. No packets are generated. In this mode, 'bump-in-the-wire' behavior is applied to Cisco Discovery Protocol packets. This is a backward compatible mode, equivalent to not having Cisco Discovery Protocol support.

Restrictions for Cisco Discovery Protocol Bypass

Cisco Discovery Protocol Bypass does not support standard ACLs on the switch port.

Information about Cisco Discovery Protocol Bypass

When a Cisco IP Phone is plugged into a port that is configured with a Voice VLAN and single-host mode, the phone will be silently allowed onto the network by way of a feature known as Cisco Discovery Protocol Bypass. The phone (or any device) that sends the appropriate Type Length Value (TLV) in a Cisco Discovery Protocol message will be allowed access to the voice VLAN.

In Cisco Discovery Protocol Bypass mode, Cisco Disocvery Protocol packets are received and transmitted unchanged. Received packets are not processed. No packets are generated. In this mode, 'bump-in-the-wire' behaviour is applied to Cisco Discovery Protocol packets. This is a backward compatible mode, equivalent to not having Cisco Discovery Protocol support.

In Cisco Discovery Protocol Bypass mode authentication sessions are established in single and multi-host modes for IP Phones. However, if voice VLAN and 802.1x on an interface port is enabled, then Cisco Discovery Protocol Bypass is enabled when the host mode is set to single or multi-host mode.

It is possible to use the Multi-Domain Authentication (MDA) feature instead of Cisco Discovery Protocol Bypass feature as it provides better Access Control, Visibility and Authorization.

Note By default the host mode is set to single mode in legacy mode and multi-authentication in the edge mode.

Cisco Discovery Protocol Enhancement for Second Port Disconnect—Allows a Cisco IP phone to send a Cisco Discovery Protocol message to the switch when a host unplugs from behind the phone. The switch is then able to clear any authenticated session for the indirectly connected host, the same as if the host had been directly connected and the switch had detected a link down event. This is supported in latest IP telephones.

Cisco Discovery Protocol Bypass provides no support for third-party phones—Cisco Discovery Protocol Bypass works only with Cisco phones.

How to configure Cisco Discovery Protocol Bypass

Follow these steps to enable Cisco Discovery Protocol Bypass:

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface** *interface-id*
4. **switchport mode access**
5. **switchport access vlan** *vlan id*
6. **switchport voice vlan** *vlan-id*
7. **authentication port-control auto**
8. **authentication host-mode** {**single-host** | **multi-host**}
9. **dot1x pae authenticator**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters the global configuration mode.
Step 3	**interface** *interface-id* **Example:** `Device(config)# interface GigabitEthernet1/0/12`	Specifies a physical port, and enters interface configuration mode. • Valid interfaces are physical ports.
Step 4	**switchport mode access** **Example:** `Device(config-if)# switchport mode access`	Specifies that the interface is in access mode.

	Command or Action	Purpose
Step 5	**switchport access vlan** *vlan id* **Example:** `Device(config-if)# switchport access vlan 10`	Assigns all ports as static-access ports in the same VLAN • If you configure the port as a static-access port, assign it to only one VLAN. The range is 1 to 4094.
Step 6	**switchport voice vlan** *vlan-id* **Example:** `Device(config-if)# switchport voice vlan 3`	Instruct the Cisco IP phone to forward all voice traffic through the specified VLAN. By default, the Cisco IP phone forwards the voice traffic with an 802.1Q priority of 5. Valid VLAN IDs are from 1 to 4094 when the enhanced software image (EI) is installed and 1 to 1001 when the standard software image is installed. Do not enter leading zeros.
Step 7	**authentication port-control auto** **Example:** `Device(config-if)# authentication port-control auto`	Enables 802.1x authentication on the port.
Step 8	**authentication host-mode** {**single-host** | **multi-host**} **Example:** `Device(config-if)# authentication host-mode single-host | multi-host`	The keywords allow the following: • single-host-Single host (client) on an IEEE 802.1X-authorized port. • multi-host-Multiple hosts on an 802.1X-authorized port after a authenticating a single host.
Step 9	**dot1x pae authenticator** **Example:** `Device(config-if)# dot1x pae authenticator`	Enables 802.1X authentication on the port with default parameters

Configuration Examples for Cisco Discovery Protocol Bypass

Example: Enabling Cisco Discovery Protocol Bypass

Cisco Discovery Protocol Bypass is enabled by default once 'Authetication port-control auto' is configured with dotx1 or MAB or if voice vlan is configured on interface along with single/multiple host mode.

This following configuration example configures Cisco Disovery Protocol Bypass when authenticating using MAB.

```
 Device(config)# interface GigabitEthernet1/0/12
Device(config-if)# switchport mode access
Device(config-if)# switchport access vlan 10
Device(config-if)# switchport voice vlan 3
Device(config-if)# authentication port-control auto
Device(config-if)# mab
```

Displaying Cisco Discovery Protocol neighbours

The following configuration example displays Cisco Discovery Protocol neighbours.

```
Device# show cdp neighbors g1/0/37 detail
Device ID: SEP24B657B038DF
Entry address(es):
Platform: Cisco IP Phone 9971,  Capabilities: Host Phone Two-port Mac Relay
Interface: GigabitEthernet1/0/37,  Port ID (outgoing port): Port 1
Holdtime : 157 sec
Second Port Status: Down <<<<<<<<<<
Version :
sip9971.9-1-1SR1
advertisement version: 2
Duplex: full
Power drawn: 12.804 Watts
Power request id: 57146, Power management id: 4
Power request levels are:12804 0 0 0 0
Total cdp entries displayed : 1
```

Example:Disabling Cisco Discovery Protocol Bypass

To disable Cisco Discovery Protocol Bypass,‘Authetication port-control auto’ needs to be removed from the interface.

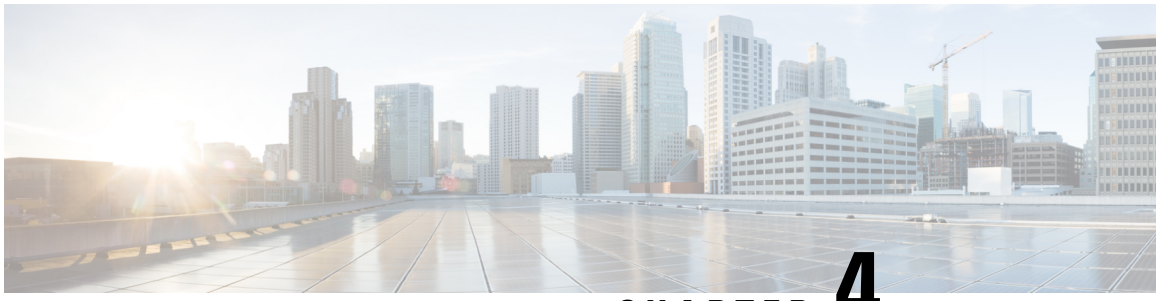
Feature Information for Cisco Discovery Protocol Bypass

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Table 2: Feature Information for Cisco Discovery Protocol Bypass

Releases	Feature Information
Cisco IOS XE Fuji 16.9.2	The feature was introduced.



CHAPTER 4

Configuring Simple Network Management Protocol

Prerequisites for SNMP

Supported SNMP Versions

This software release supports the following SNMP versions:

- SNMPv1—The Simple Network Management Protocol, a Full Internet Standard, defined in RFC 1157.
- SNMPv2C replaces the Party-based Administrative and Security Framework of SNMPv2Classic with the community-string-based Administrative Framework of SNMPv2C while retaining the bulk retrieval and improved error handling of SNMPv2Classic. It has these features:
  - SNMPv2—Version 2 of the Simple Network Management Protocol, a Draft Internet Standard, defined in RFCs 1902 through 1907.
  - SNMPv2C—The community-string-based Administrative Framework for SNMPv2, an Experimental Internet Protocol defined in RFC 1901.
- SNMPv3—Version 3 of the SNMP is an interoperable standards-based protocol defined in RFCs 2273 to 2275. SNMPv3 provides secure access to devices by authenticating and encrypting packets over the network and includes these security features:
  - Message integrity—Ensures that a packet was not tampered with in transit.
  - Authentication—Determines that the message is from a valid source.
  - Encryption—Mixes the contents of a package to prevent it from being read by an unauthorized source.

Note To select encryption, enter the **priv** keyword.

Both SNMPv1 and SNMPv2C use a community-based form of security. The community of managers able to access the agent's MIB is defined by an IP address access control list and password.

SNMPv2C includes a bulk retrieval function and more detailed error message reporting to management stations. The bulk retrieval function retrieves tables and large quantities of information, minimizing the number of round-trips required. The SNMPv2C improved error-handling 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 in SNMPv2C report the error type.

SNMPv3 provides for both security models and security levels. A security model is an authentication strategy set up for a user and the group within which the user resides. A security level is the permitted level of security within a security model. A combination of the security level and the security model determine which security method is used when handling an SNMP packet. Available security models are SNMPv1, SNMPv2C, and SNMPv3.

The following table identifies characteristics and compares different combinations of security models and levels:

Table 3: SNMP Security Models and Levels

Model	Level	Authentication	Encryption	Result
SNMPv1	noAuthNoPriv	Community string	No	Uses a community string match for authentication.
SNMPv2C	noAuthNoPriv	Community string	No	Uses a community string match for authentication.
SNMPv3	noAuthNoPriv	Username	No	Uses a username match for authentication.
SNMPv3	authNoPriv	Message Digest 5 (MD5) or Secure Hash Algorithm (SHA)	No	Provides authentication based on the HMAC-MD5 or HMAC-SHA algorithms.

Model	Level	Authentication	Encryption	Result
SNMPv3	authPriv	MD5 or SHA	Data Encryption Standard (DES) or Advanced Encryption Standard (AES)	Provides authentication based on the HMAC-MD5 or HMAC-SHA algorithms. Allows specifying the User-based Security Model (USM) with these encryption algorithms: • DES 56-bit encryption in addition to authentication based on the CBC-DES (DES-56) standard. • 3DES 168-bit encryption • AES 128-bit, 192-bit, or 256-bit encryption

You must configure the SNMP agent to use the SNMP version supported by the management station. Because an agent can communicate with multiple managers, you can configure the software to support communications using SNMPv1, SNMPv2C, or SNMPv3.

Restrictions for SNMP

Version Restrictions

- SNMPv1 does not support informs.

SNMPv3 authentication is not supported in the following scenarios:

- If there is a change in the switch priority followed by stack reload.
- If a device with a lower mac address is added to the stack, the device will be elected as the active switch if all the switches in the stack have the same priority.

To avoid SNMPv3 authentication failure, you should manually configure SNMP engineID on the device before SNMPv3 user configuration. With this, the user can manage and administer the device as the user is tied to the engineID.

Information About SNMP

SNMP Overview

SNMP is an application-layer protocol that provides a message format for communication between managers and agents. The SNMP system consists of an SNMP manager, an SNMP agent, and a management information base (MIB). The SNMP manager can be part of a network management system (NMS) such as Cisco Prime Infrastructure. The agent and MIB reside on the device. To configure SNMP on the device, you define the relationship between the manager and the agent.

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

An agent can send unsolicited traps to the manager. Traps are messages alerting the SNMP manager to a condition on the network. Traps can mean improper user authentication, restarts, link status (up or down), MAC address tracking, closing of a TCP connection, loss of connection to a neighbor, or other significant events.

SNMP Manager Functions

The SNMP manager uses information in the MIB to perform the operations described in the following table:

Table 4: SNMP Operations

Operation	Description
get-request	Retrieves a value from a specific variable.
get-next-request	Retrieves a value from a variable within a table.[1]
get-bulk-request[2]	Retrieves large blocks of data, such as multiple rows in a table, that would otherwise require the transmission of many small blocks of data.
get-response	Replies to a get-request, get-next-request, and set-request sent by an NMS.
set-request	Stores a value in a specific variable.
trap	An unsolicited message sent by an SNMP agent to an SNMP manager when some event has occurred.

[1] With this operation, an SNMP manager does not need to know the exact variable name. A sequential search is performed to find the needed variable from within a table.
[2] The get-bulk command only works with SNMPv2 or later.

SNMP Agent Functions

The SNMP agent responds to SNMP manager requests as follows:

- Get a MIB variable—The SNMP agent begins this function in response to a request from the NMS. The agent retrieves the value of the requested MIB variable and responds to the NMS with that value.

- Set a MIB variable—The SNMP agent begins this function in response to a message from the NMS. The SNMP agent changes the value of the MIB variable to the value requested by the NMS.

The SNMP agent also sends unsolicited trap messages to notify an NMS that a significant event has occurred on the agent. Examples of trap conditions include, but are not limited to, when a port or module goes up or down, when spanning-tree topology changes occur, and when authentication failures occur.

SNMP Community Strings

SNMP community strings authenticate access to MIB objects and function as embedded passwords. In order for the NMS to access the device, the community string definitions on the NMS must match at least one of the three community string definitions on the device.

A community string can have one of the following attributes:

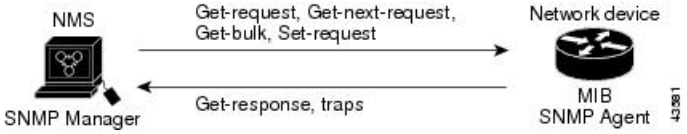
- Read-only (RO)—Gives all objects in the MIB except the community strings read access to authorized management stations, but does not allow write access.
- Read-write (RW)—Gives all objects in the MIB read and write access to authorized management stations, but does not allow access to the community strings.
- When a cluster is created, the command device manages the exchange of messages among member devices and the SNMP application. The Network Assistant software appends the member device number (@esN, where N is the device number) to the first configured RW and RO community strings on the command device and propagates them to the member devices.

SNMP MIB Variables Access

An example of an NMS is the Cisco Prime Infrastructure network management software. Cisco Prime Infrastructure software uses the device MIB variables to set device variables and to poll devices on the network for specific information. The results of a poll can be displayed as a graph and analyzed to troubleshoot internetworking problems, increase network performance, verify the configuration of devices, monitor traffic loads, and more.

As shown in the figure, the SNMP agent gathers data from the MIB. The agent can send traps, or notification of certain events, to the SNMP manager, which receives and processes the traps. Traps alert the SNMP manager to a condition on the network such as improper user authentication, restarts, link status (up or down), MAC address tracking, and so forth. The SNMP agent also responds to MIB-related queries sent by the SNMP manager in *get-request*, *get-next-request*, and *set-request* format.

Figure 1: SNMP Network



SNMP Notifications

SNMP allows the device to send notifications to SNMP managers when particular events occur. SNMP notifications can be sent as traps or inform requests. In command syntax, unless there is an option in the

command to select either traps or informs, the keyword traps refers to either traps or informs, or both. Use the **snmp-server host** command to specify whether to send SNMP notifications as traps or informs.

Note SNMPv1 does not support informs.

Traps are unreliable because the receiver does not send an acknowledgment when it receives a trap, and the sender cannot determine if the trap was received. When an SNMP manager receives an inform request, it acknowledges the message with an SNMP response protocol data unit (PDU). If the sender does not receive a response, the inform request can be sent again. Because they can be resent, informs are more likely than traps to reach their intended destination.

The characteristics that make informs more reliable than traps also consume more resources in the device and in the network. Unlike a trap, which is discarded as soon as it is sent, an inform request is held in memory until a response is received or the request times out. Traps are sent only once, but an inform might be resent or retried several times. The retries increase traffic and contribute to a higher overhead on the network. Therefore, traps and informs require a trade-off between reliability and resources. If it is important that the SNMP manager receive every notification, use inform requests. If traffic on the network or memory in the device is a concern and notification is not required, use traps.

SNMP ifIndex MIB Object Values

The SNMP agent's IF-MIB module comes up shortly after reboot. As various physical interface drivers are initialized they register with the IF-MIB module, essentially saying "Give me an ifIndex number". The IF-MIB module assigns the next available ifIndex number on a first-come-first-served basis. That is, minor differences in driver initialization order from one reboot to another can result in the same physical interface getting a different ifIndex number than it had before the reboot (unless ifIndex persistency is enabled of course).

Default SNMP Configuration

Feature	Default Setting
SNMP agent	Disabled[3].
SNMP trap receiver	None configured.
SNMP traps	None enabled except the trap for TCP connections (tty).
SNMP version	If no version keyword is present, the default is Version 1.
SNMPv3 authentication	If no keyword is entered, the default is the **noauth** (noAuthNoPriv) security level.
SNMP notification type	If no type is specified, all notifications are sent.

[3] This is the default when the device starts and the startup configuration does not have any **snmp-server** global configuration commands.

SNMP Configuration Guidelines

If the device starts and the device startup configuration has at least one **snmp-server** global configuration command, the SNMP agent is enabled.

An SNMP *group* is a table that maps SNMP users to SNMP views. An SNMP *user* is a member of an SNMP group. An SNMP *host* is the recipient of an SNMP trap operation. An SNMP *engine ID* is a name for the local or remote SNMP engine.

When configuring SNMP, follow these guidelines:

- When configuring an SNMP group, do not specify a notify view. The **snmp-server host** global configuration command auto-generates a notify view for the user and then adds it to the group associated with that user. Modifying the group's notify view affects all users associated with that group.
- To configure a remote user, specify the IP address or port number for the remote SNMP agent of the device where the user resides.
- Before you configure remote users for a particular agent, configure the SNMP engine ID, using the **snmp-server engineID** global configuration command with the **remote** option. The remote agent's SNMP engine ID and user password are used to compute the authentication and privacy digests. If you do not configure the remote engine ID first, the configuration command fails.
- When configuring SNMP informs, you need to configure the SNMP engine ID for the remote agent in the SNMP database before you can send proxy requests or informs to it.
- If a local user is not associated with a remote host, the device does not send informs for the **auth** (authNoPriv) and the **priv** (authPriv) authentication levels.
- Changing the value of the SNMP engine ID has significant results. A user's password (entered on the command line) is converted to an MD5 or SHA security digest based on the password and the local engine ID. The command-line password is then destroyed, as required by RFC 2274. Because of this deletion, if the value of the engine ID changes, the security digests of SNMPv3 users become invalid, and you need to reconfigure SNMP users by using the **snmp-server user** *username* global configuration command. Similar restrictions require the reconfiguration of community strings when the engine ID changes.

How to Configure SNMP

Configuring Community Strings

You use the SNMP community string to define the relationship between the SNMP manager and the agent. The community string acts like a password to permit access to the agent on the device. Optionally, you can specify one or more of these characteristics associated with the string:

- An access list of IP addresses of the SNMP managers that are permitted to use the community string to gain access to the agent
- A MIB view, which defines the subset of all MIB objects accessible to the given community
- Read and write or read-only permission for the MIB objects accessible to the community

Follow these steps to configure a community string on the device.

SUMMARY STEPS

1. **enable**

2. **configure terminal**
3. **snmp-server community** *string* [**view** *view-name*] [**ro** | **rw**] [*access-list-number*]
4. **access-list** *access-list-number* {**deny** | **permit**} *source* [*source-wildcard*]
5. **end**
6. **show running-config**
7. **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**snmp-server community** *string* [**view** *view-name*] [**ro**	**rw**] [*access-list-number*] **Example:** `Device(config)# snmp-server community comaccess ro 4`	Configures the community string. **Note** The @ symbol is used for delimiting the context information. Avoid using the @ symbol as part of the SNMP community string when configuring this command. • For *string*, specify a string that acts like a password and permits access to the SNMP protocol. You can configure one or more community strings of any length. • (Optional) For **view**, specify the view record accessible to the community. • (Optional) Specify either read-only (**ro**) if you want authorized management stations to retrieve MIB objects, or specify read-write (**rw**) if you want authorized management stations to retrieve and modify MIB objects. By default, the community string permits read-only access to all objects. • (Optional) For *access-list-number*, enter an IP standard access list numbered from 1 to 99 and 1300 to 1999.

	Command or Action	Purpose
Step 4	**access-list** *access-list-number* {**deny** | **permit**} *source* [*source-wildcard*] **Example:** `Device(config)# access-list 4 deny any`	(Optional) If you specified an IP standard access list number in Step 3, then create the list, repeating the command as many times as necessary. • For *access-list-number*, enter the access list number specified in Step 3. • The **deny** keyword denies access if the conditions are matched. The **permit** keyword permits access if the conditions are matched. • For *source*, enter the IP address of the SNMP managers that are permitted to use the community string to gain access to the agent. • (Optional) For *source-wildcard*, enter the wildcard bits in dotted decimal notation to be applied to the source. Place ones in the bit positions that you want to ignore. Recall that the access list is always terminated by an implicit deny statement for everything.
Step 5	**end** **Example:** `Device(config)# end`	Returns to privileged EXEC mode.
Step 6	**show running-config** **Example:** `Device# show running-config`	Verifies your entries.
Step 7	**copy running-config startup-config** **Example:** `Device# copy running-config startup-config`	(Optional) Saves your entries in the configuration file.

What to do next

To disable access for an SNMP community, set the community string for that community to the null string (do not enter a value for the community string).

To remove a specific community string, use the **no snmp-server** community string global configuration command.

You can specify an identification name (engine ID) for the local or remote SNMP server engine on the device. You can configure an SNMP server group that maps SNMP users to SNMP views, and you can add new users to the SNMP group.

Configuring SNMP Groups and Users

You can specify an identification name (engine ID) for the local or remote SNMP server engine on the device. You can configure an SNMP server group that maps SNMP users to SNMP views, and you can add new users to the SNMP group.

Follow these steps to configure SNMP groups and users on the device.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **snmp-server engineID** {**local** *engineid-string* | **remote** *ip-address* [**udp-port** *port-number*] *engineid-string*}
4. **snmp-server group** *group-name* {**v1** | **v2c** | **v3** {**auth** | **noauth** | **priv**}} [**read** *readview*] [**write** *writeview*] [**notify** *notifyview*] [**access** *access-list*]
5. **snmp-server user** *username group-name* {**remote** *host* [**udp-port** *port*] } {**v1** [**access** *access-list*] | **v2c** [**access** *access-list*] | **v3** [**encrypted**] [**access** *access-list*] [**auth** {**md5** | **sha**} *auth-password*] } [*priv* {**des** | **3des** | **aes** {**128** | **192** | **256**}} *priv-password*]
6. **end**
7. **show running-config**
8. **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**snmp-server engineID** {**local** *engineid-string* | **remote** *ip-address* [**udp-port** *port-number*] *engineid-string*} **Example:** `Device(config)# snmp-server engineID local 1234`	Configures a name for either the local or remote copy of SNMP. • The *engineid-string* is a 24-character ID string with the name of the copy of SNMP. You need not specify the entire 24-character engine ID if it has trailing zeros. Specify only the portion of the engine ID up to the point where only zeros remain in the value. The Step Example configures an engine ID of 123400000000000000000000. • If you select **remote**, specify the *ip-address* of the device that contains the remote copy of SNMP and the

	Command or Action	Purpose
		optional User Datagram Protocol (UDP) port on the remote device. The default is 162.
Step 4	**snmp-server group** *group-name* {**v1** | **v2c** | **v3** {**auth** | **noauth** | **priv**}} [**read** *readview*] [**write** *writeview*] [**notify** *notifyview*] [**access** *access-list*] **Example:** `Device(config)# snmp-server group public v2c access lmnop`	Configures a new SNMP group on the remote device. For *group-name*, specify the name of the group. Specify one of the following security models: • **v1** is the least secure of the possible security models. • **v2c** is the second least secure model. It allows transmission of informs and integers twice the normal width. • **v3**, the most secure, requires you to select one of the following authentication levels: **auth**—Enables the Message Digest 5 (MD5) and the Secure Hash Algorithm (SHA) packet authentication. **noauth**—Enables the noAuthNoPriv security level. This is the default if no keyword is specified. **priv**—Enables Data Encryption Standard (DES) packet encryption (also called privacy). (Optional) Enter **read** *readview* with a string (not to exceed 64 characters) that is the name of the view in which you can only view the contents of the agent. (Optional) Enter **write** *writeview* with a string (not to exceed 64 characters) that is the name of the view in which you enter data and configure the contents of the agent. (Optional) Enter **notify** *notifyview* with a string (not to exceed 64 characters) that is the name of the view in which you specify a notify, inform, or trap. (Optional) Enter **access** *access-list* with a string (not to exceed 64 characters) that is the name of the access list.
Step 5	**snmp-server user** *username group-name* {**remote** *host* [**udp-port** *port*]} {**v1** [**access** *access-list*] | **v2c** [**access** *access-list*] | **v3** [**encrypted**] [**access** *access-list*] [**auth** {**md5** | **sha**} *auth-password*] } [*priv* {**des** | **3des** | **aes** {**128** | **192** | **256**}} *priv-password*] **Example:** `Device(config)# snmp-server user Pat public v2c`	Adds a new user for an SNMP group. The *username* is the name of the user on the host that connects to the agent. The *group-name* is the name of the group to which the user is associated. Enter **remote** to specify a remote SNMP entity to which the user belongs and the hostname or IP address of that entity with the optional UDP port number. The default is 162. Enter the SNMP version number (**v1**, **v2c**, or **v3**). If you enter **v3**, you have these additional options:

	Command or Action	Purpose
		• **encrypted** specifies that the password appears in encrypted format. This keyword is available only when the **v3** keyword is specified. • **auth** is an authentication level setting session that can be either the HMAC-MD5-96 (**md5**) or the HMAC-SHA-96 (**sha**) authentication level and requires a password string *auth-password* (not to exceed 64 characters). If you enter **v3** you can also configure a private (**priv**) encryption algorithm and password string *priv-password* using the following keywords (not to exceed 64 characters): • **priv** specifies the User-based Security Model (USM). • **des** specifies the use of the 56-bit DES algorithm. • **3des** specifies the use of the 168-bit DES algorithm. • **aes** specifies the use of the DES algorithm. You must select either 128-bit, 192-bit, or 256-bit encryption. (Optional) Enter **access** *access-list* with a string (not to exceed 64 characters) that is the name of the access list.
Step 6	**end** **Example:** `Device(config)# end`	Returns to privileged EXEC mode.
Step 7	**show running-config** **Example:** `Device# show running-config`	Verifies your entries.
Step 8	**copy running-config startup-config** **Example:** `Device# copy running-config startup-config`	(Optional) Saves your entries in the configuration file.

Configuring SNMP Notifications

A trap manager is a management station that receives and processes traps. Traps are system alerts that the device generates when certain events occur. By default, no trap manager is defined, and no traps are sent. Devices running this Cisco IOS release can have an unlimited number of trap managers.

Note Many commands use the word **traps** in the command syntax. Unless there is an option in the command to select either traps or informs, the keyword **traps** refers to traps, informs, or both. Use the **snmp-server host** global configuration command to specify whether to send SNMP notifications as traps or informs.

You can use the **snmp-server host** global configuration command for a specific host to receive the notification types listed in the following table. You can enable any or all of these traps and configure a trap manager to receive them.

Follow these steps to configure the device to send traps or informs to a host.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **snmp-server engineID remote** *ip-address engineid-string*
4. **snmp-server user** *username group-name* {**remote** *host* [**udp-port** *port*] } {**v1** [**access** *access-list*] | **v2c** [**access** *access-list*] | **v3** [**encrypted**] [**access** *access-list*] [**auth** {**md5** | **sha**} *auth-password*] }
5. **snmp-server group** *group-name* {**v1** | **v2c** | **v3** {**auth** | **noauth** | **priv**} } [**read** *readview*] [**write** *writeview*] [**notify** *notifyview*] [**access** *access-list*]
6. **snmp-server host** *host-addr* [**informs** | **traps**] [**version** {**1** | **2c** | **3** {**auth** | **noauth** | **priv**} }] *community-string* [*notification-type*]
7. **snmp-server enable traps** *notification-types*
8. **snmp-server trap-source** *interface-id*
9. **snmp-server queue-length** *length*
10. **snmp-server trap-timeout** *seconds*
11. **end**
12. **show running-config**
13. **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.

	Command or Action	Purpose
Step 3	**snmp-server engineID remote** *ip-address engineid-string* **Example:** `Device(config)# snmp-server engineID remote 192.180.1.27 00000063000100a1c0b4011b`	Specifies the engine ID for the remote host.
Step 4	**snmp-server user** *username group-name* {**remote** *host* [**udp-port** *port*] } {**v1** [**access** *access-list*] | **v2c** [**access** *access-list*] | **v3** [**encrypted**] [**access** *access-list*] [**auth** {**md5** | **sha**} *auth-password*] } **Example:** `Device(config)# snmp-server user Pat public v2c`	Configures an SNMP user to be associated with the remote host created in Step 3. **Note** You cannot configure a remote user for an address without first configuring the engine ID for the remote host. Otherwise, you receive an error message, and the command is not executed.
Step 5	**snmp-server group** *group-name* {**v1** | **v2c** | **v3** {**auth** | **noauth** | **priv**} } [**read** *readview*] [**write** *writeview*] [**notify** *notifyview*] [**access** *access-list*] **Example:** `Device(config)# snmp-server group public v2c access lmnop`	Configures an SNMP group.
Step 6	**snmp-server host** *host-addr* [**informs** | **traps**] [**version** {**1** | **2c** | **3** {**auth** | **noauth** | **priv**} }] *community-string* [*notification-type*] **Example:** `Device(config)# snmp-server host 203.0.113.1 comaccess snmp`	Specifies the recipient of an SNMP trap operation. For *host-addr*, specify the name or Internet address of the host (the targeted recipient). (Optional) Specify **traps** (the default) to send SNMP traps to the host. (Optional) Specify **informs** to send SNMP informs to the host. (Optional) Specify the SNMP **version** (**1**, **2c**, or **3**). SNMPv1 does not support informs. (Optional) For Version 3, select authentication level **auth**, **noauth**, or **priv**. **Note** The **priv** keyword is available only when the cryptographic software image is installed. For *community-string*, when **version 1** or **version 2c** is specified, enter the password-like community string sent with the notification operation. When **version 3** is specified, enter the SNMPv3 username. The @ symbol is used for delimiting the context information. Avoid using the @ symbol as part of the SNMP community string when configuring this command. (Optional) For *notification-type*, use the keywords listed in the table above. If no type is specified, all notifications are sent.

	Command or Action	Purpose
Step 7	**snmp-server enable traps** *notification-types* **Example:** `Device(config)# snmp-server enable traps snmp`	Enables the device to send traps or informs and specifies the type of notifications to be sent. For a list of notification types, see the table above, or enter **snmp-server enable traps ?** To enable multiple types of traps, you must enter a separate **snmp-server enable traps** command for each trap type. **Note** When you configure a trap by using the notification type **port-security**, configure the port security trap first, and then configure the port security trap rate: **a. snmp-server enable traps port-security** **b. snmp-server enable traps port-security trap-rate** *rate*
Step 8	**snmp-server trap-source** *interface-id* **Example:** `Device(config)# snmp-server trap-source gigabitethernet 1/0/1`	(Optional) Specifies the source interface, which provides the IP address for the trap message. This command also sets the source IP address for informs.
Step 9	**snmp-server queue-length** *length* **Example:** `Device(config)# snmp-server queue-length 20`	(Optional) Establishes the message queue length for each trap host. The range is 1 to 5000; the default is 10.
Step 10	**snmp-server trap-timeout** *seconds* **Example:** `Device(config)# snmp-server trap-timeout 60`	(Optional) Defines how often to resend trap messages. The range is 1 to 1000; the default is 30 seconds.
Step 11	**end** **Example:** `Device(config)# end`	Returns to privileged EXEC mode.
Step 12	**show running-config** **Example:** `Device# show running-config`	Verifies your entries.
Step 13	**copy running-config startup-config** **Example:** `Device# copy running-config startup-config`	(Optional) Saves your entries in the configuration file.

What to do next

The **snmp-server host** command specifies which hosts receive the notifications. The **snmp-server enable traps** command globally enables the method for the specified notification (for traps and informs). To enable a host to receive an inform, you must configure an **snmp-server host informs** command for the host and globally enable informs by using the **snmp-server enable traps** command.

To remove the specified host from receiving traps, use the **no snmp-server host** *host* global configuration command. The **no snmp-server host** command with no keywords disables traps, but not informs, to the host. To disable informs, use the **no snmp-server host informs** global configuration command. To disable a specific trap type, use the **no snmp-server enable traps** *notification-types* global configuration command.

Setting the Agent Contact and Location Information

Follow these steps to set the system contact and location of the SNMP agent so that these descriptions can be accessed through the configuration file.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **snmp-server contact** *text*
4. **snmp-server location** *text*
5. **end**
6. **show running-config**
7. **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**snmp-server contact** *text* **Example:** `Device(config)# snmp-server contact Dial System Operator at beeper 21555`	Sets the system contact string.
Step 4	**snmp-server location** *text* **Example:**	Sets the system location string.

	Command or Action	Purpose
	`Device(config)# snmp-server location Building 3/Room 222`	
Step 5	**end** **Example:** `Device(config)# end`	Returns to privileged EXEC mode.
Step 6	**show running-config** **Example:** `Device# show running-config`	Verifies your entries.
Step 7	**copy running-config startup-config** **Example:** `Device# copy running-config startup-config`	(Optional) Saves your entries in the configuration file.

Limiting TFTP Servers Used Through SNMP

Follow these steps to limit the TFTP servers used for saving and loading configuration files through SNMP to the servers specified in an access list.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **snmp-server tftp-server-list** *access-list-number*
4. **access-list** *access-list-number* {**deny** | **permit**} *source* [*source-wildcard*]
5. **end**
6. **show running-config**
7. **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:**	Enters global configuration mode.

	Command or Action	Purpose
	`Device# configure terminal`	
Step 3	**snmp-server tftp-server-list** *access-list-number* **Example:** `Device(config)# snmp-server tftp-server-list 44`	Limits the TFTP servers used for configuration file copies through SNMP to the servers in the access list. For *access-list-number*, enter an IP standard access list numbered from 1 to 99 and 1300 to 1999.
Step 4	**access-list** *access-list-number* {**deny** | **permit**} *source* [*source-wildcard*] **Example:** `Device(config)# access-list 44 permit 10.1.1.2`	Creates a standard access list, repeating the command as many times as necessary. For *access-list-number*, enter the access list number specified in Step 3. The **deny** keyword denies access if the conditions are matched. The **permit** keyword permits access if the conditions are matched. For *source*, enter the IP address of the TFTP servers that can access the device. (Optional) For *source-wildcard*, enter the wildcard bits, in dotted decimal notation, to be applied to the source. Place ones in the bit positions that you want to ignore. The access list is always terminated by an implicit deny statement for everything.
Step 5	**end** **Example:** `Device(config)# end`	Returns to privileged EXEC mode.
Step 6	**show running-config** **Example:** `Device# show running-config`	Verifies your entries.
Step 7	**copy running-config startup-config** **Example:** `Device# copy running-config startup-config`	(Optional) Saves your entries in the configuration file.

Disabling the SNMP Agent

The **no snmp-server** global configuration command disables all running versions (Version 1, Version 2C, and Version 3) of the SNMP agent on the device. You reenable all versions of the SNMP agent by the first

snmp-server global configuration command that you enter. There is no Cisco IOS command specifically designated for enabling SNMP.

Follow these steps to disable the SNMP agent.

Before you begin

The SNMP Agent must be enabled before it can be disabled. The SNMP agent is enabled by the first **snmp-server** global configuration command entered on the device.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **no snmp-server**
4. **end**
5. **show running-config**
6. **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**no snmp-server** **Example:** `Device(config)# no snmp-server`	Disables the SNMP agent operation.
Step 4	**end** **Example:** `Device(config)# end`	Returns to privileged EXEC mode.
Step 5	**show running-config** **Example:** `Device# show running-config`	Verifies your entries.

	Command or Action	Purpose
Step 6	**copy running-config startup-config** **Example:** `Device# copy running-config startup-config`	(Optional) Saves your entries in the configuration file.

Monitoring SNMP Status

To display SNMP input and output statistics, including the number of illegal community string entries, errors, and requested variables, use the **show snmp** privileged EXEC command. You also can use the other privileged EXEC commands listed in the table to display SNMP information.

Table 5: Commands for Displaying SNMP Information

Command	Purpose
show snmp	Displays SNMP statistics.
	Displays information on the local SNMP engine and all remote engines that have been configured on the device.
show snmp group	Displays information on each SNMP group on the network.
show snmp pending	Displays information on pending SNMP requests.
show snmp sessions	Displays information on the current SNMP sessions.
show snmp user	Displays information on each SNMP user name in the SNMP users table. **Note** You must use this command to display SNMPv3 configuration information for **auth** | **noauth** | **priv** mode. This information is not displayed in the **show running-config** output.

SNMP Examples

This example shows how to enable all versions of SNMP. The configuration permits any SNMP manager to access all objects with read-only permissions using the community string *public*. This configuration does not cause the device to send any traps.

```
Device(config)# snmp-server community public
```

This example shows how to permit any SNMP manager to access all objects with read-only permission using the community string *public*. The device also sends VTP traps to the hosts 192.180.1.111 and 192.180.1.33

using SNMPv1 and to the host 192.180.1.27 using SNMPv2C. The community string *public* is sent with the traps.

```
Device(config)# snmp-server community public
Device(config)# snmp-server enable traps vtp
Device(config)# snmp-server host 192.180.1.27 version 2c public
Device(config)# snmp-server host 192.180.1.111 version 1 public
Device(config)# snmp-server host 192.180.1.33 public
```

This example shows how to allow read-only access for all objects to members of access list 4 that use the *comaccess* community string. No other SNMP managers have access to any objects. SNMP Authentication Failure traps are sent by SNMPv2C to the host *cisco.com* using the community string *public*.

```
Device(config)# snmp-server community comaccess ro 4
Device(config)# snmp-server enable traps snmp authentication
Device(config)# snmp-server host cisco.com version 2c public
```

This example shows how to send Entity MIB traps to the host *cisco.com*. The community string is restricted. The first line enables the device to send Entity MIB traps in addition to any traps previously enabled. The second line specifies the destination of these traps and overwrites any previous **snmp-server** host commands for the host *cisco.com*.

```
Device(config)# snmp-server enable traps entity
Device(config)# snmp-server host cisco.com restricted entity
```

This example shows how to enable the device to send all traps to the host *myhost.cisco.com* using the community string *public*:

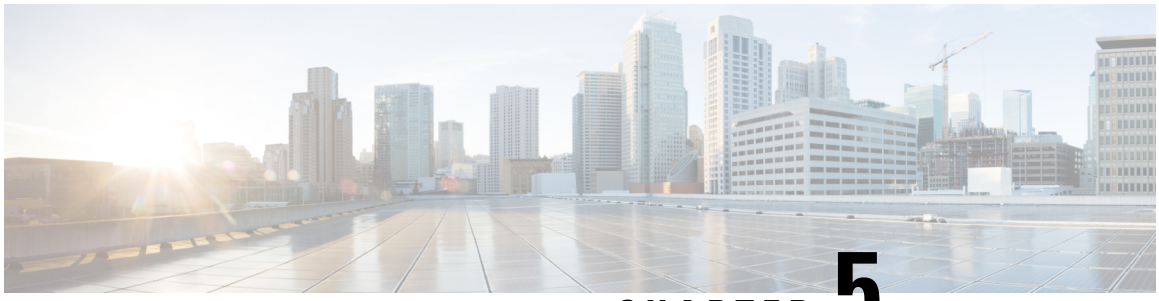
```
Device(config)# snmp-server enable traps
Device(config)# snmp-server host myhost.cisco.com public
```

This example shows how to associate a user with a remote host and to send **auth** (authNoPriv) authentication-level informs when the user enters global configuration mode:

```
Device(config)# snmp-server engineID remote 192.180.1.27 00000063000100a1c0b4011b
Device(config)# snmp-server group authgroup v3 auth
Device(config)# snmp-server user authuser authgroup remote 192.180.1.27 v3 auth md5 mypassword
Device(config)# snmp-server user authuser authgroup v3 auth md5 mypassword
Device(config)# snmp-server host 192.180.1.27 informs version 3 auth authuser config
Device(config)# snmp-server enable traps
Device(config)# snmp-server inform retries 0
```

Feature History and Information for Simple Network Management Protocol

Release	Modification
Cisco IOS XE Fuji 16.9.2	This feature was introduced.



CHAPTER 5

Configuring Service Level Agreements

This chapter describes how to use Cisco IOS IP Service Level Agreements (SLAs) on the switch.

Unless otherwise noted, the term *switch* refers to a standalone switch or a switch stack.

Restrictions on SLAs

This section lists the restrictions on SLAs.

The following are restrictions on IP SLAs network performance measurement:

- The device does not support VoIP service levels using the gatekeeper registration delay operations measurements.
- Only a Cisco IOS device can be a source for a destination IP SLAs responder.
- You cannot configure the IP SLAs responder on non-Cisco devices and Cisco IOS IP SLAs can send operational packets only to services native to those devices.

Information About SLAs

Cisco IOS IP Service Level Agreements (SLAs)

Cisco IOS IP SLAs send data across the network to measure performance between multiple network locations or across multiple network paths. They simulate network data and IP services and collect network performance information in real time. Cisco IOS IP SLAs generate and analyze traffic either between Cisco IOS devices or from a Cisco IOS device to a remote IP device such as a network application server. Measurements provided

by the various Cisco IOS IP SLA operations can be used for troubleshooting, for problem analysis, and for designing network topologies.

Depending on the specific Cisco IOS IP SLA operations, various network performance statistics are monitored within the Cisco device and stored in both command-line interface (CLI) and Simple Network Management Protocol (SNMP) MIBs. IP SLA packets have configurable IP and application layer options such as source and destination IP address, User Datagram Protocol (UDP)/TCP port numbers, a type of service (ToS) byte (including Differentiated Services Code Point [DSCP] and IP Prefix bits), Virtual Private Network (VPN) routing/forwarding instance (VRF), and URL web address.

Because Cisco IP SLAs are Layer 2 transport independent, you can configure end-to-end operations over disparate networks to best reflect the metrics that an end user is likely to experience. IP SLAs collect and analyze the following performance metrics:

- Delay (both round-trip and one-way)
- Jitter (directional)
- Packet loss (directional)
- Packet sequencing (packet ordering)
- Path (per hop)
- Connectivity (directional)
- Server or website download time

Because Cisco IOS IP SLAs is SNMP-accessible, it can also be used by performance-monitoring applications like Cisco Prime Internetwork Performance Monitor (IPM) and other third-party Cisco partner performance management products.

Using IP SLAs can provide the following benefits:

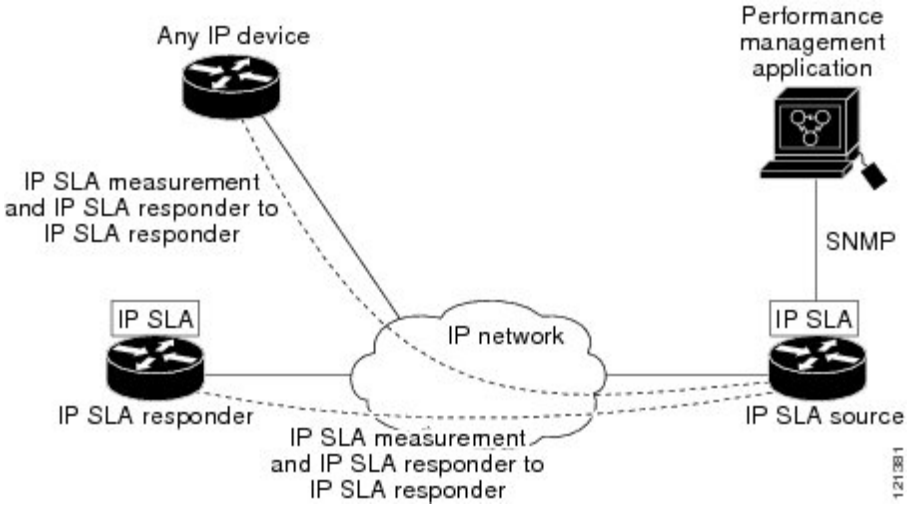
- Service-level agreement monitoring, measurement, and verification.
- Network performance monitoring
    - Measurement of jitter, latency, or packet loss in the network.
    - Continuous, reliable, and predictable measurements.
- IP service network health assessment to verify that the existing QoS is sufficient for new IP services.
- Edge-to-edge network availability monitoring for proactive verification and connectivity testing of network resources (for example, shows the network availability of an NFS server used to store business critical data from a remote site).
- Network operation troubleshooting by providing consistent, reliable measurement that immediately identifies problems and saves troubleshooting time.
- Multiprotocol Label Switching (MPLS) performance monitoring and network verification (if the device supports MPLS).

Network Performance Measurement with Cisco IOS IP SLAs

You can use IP SLAs to monitor the performance between any area in the network—core, distribution, and edge—without deploying a physical probe. It uses generated traffic to measure network performance between two networking devices.

Figure 2: Cisco IOS IP SLAs Operation

The following figure shows how IP SLAs begin when the source device sends a generated packet to the destination device. After the destination device receives the packet, depending on the type of IP SLAs operation, it responds with time-stamp information for the source to make the calculation on performance metrics. An IP SLAs operation performs a network measurement from the source device to a destination in the network using a specific protocol such as UDP.



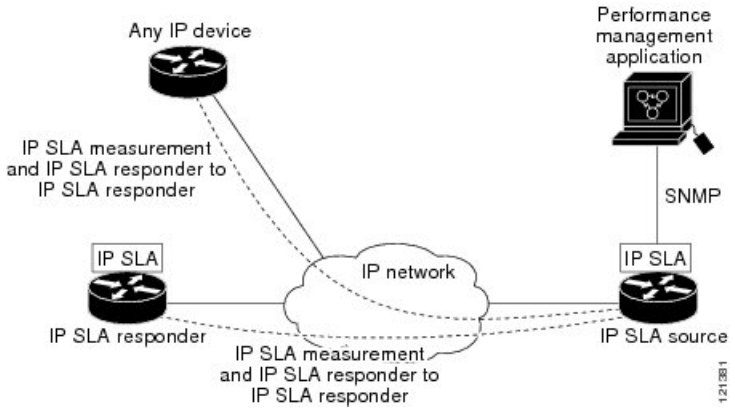
IP SLA Responder and IP SLA Control Protocol

The IP SLA responder is a component embedded in the destination Cisco device that allows the system to anticipate and respond to IP SLA request packets. The responder provides accurate measurements without the need for dedicated probes. The responder uses the Cisco IOS IP SLA Control Protocol to provide a mechanism through which it can be notified on which port it should listen and respond.

Note The IP SLA responder can be a Cisco IOS Layer 2, responder-configurable device. The responder does not need to support full IP SLA functionality.

The following figure shows where the Cisco IOS IP SLA responder fits in the IP network. The responder listens on a specific port for control protocol messages sent by an IP SLA operation. Upon receipt of the control message, it enables the specified UDP or TCP port for the specified duration. During this time, the responder accepts the requests and responds to them. It disables the port after it responds to the IP SLA packet, or when the specified time expires. MD5 authentication for control messages is available for added security.

Figure 3: Cisco IOS IP SLAs Operation



You do not need to enable the responder on the destination device for all IP SLA operations. For example, a responder is not required for services that are already provided by the destination router (such as Telnet or HTTP).

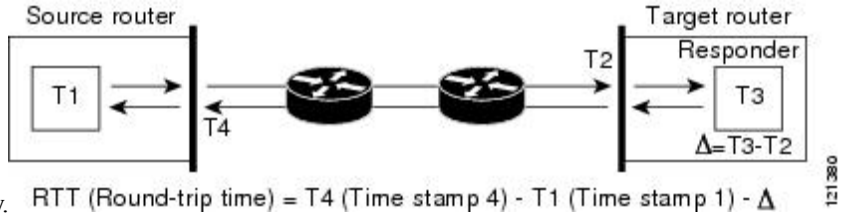
Response Time Computation for IP SLAs

Switches, controllers, and routers can take tens of milliseconds to process incoming packets due to other high priority processes. This delay affects the response times because the test-packet reply might be in a queue while waiting to be processed. In this situation, the response times would not accurately represent true network delays. IP SLAs minimize these processing delays on the source device as well as on the target device (if the responder is being used) to determine true round-trip times. IP SLA test packets use time stamping to minimize the processing delays.

When the IP SLA responder is enabled, it allows the target device to take time stamps when the packet arrives on the interface at interrupt level and again just as it is leaving, eliminating the processing time. This time stamping is made with a granularity of sub-milliseconds (ms).

Figure 4: Cisco IOS IP SLA Responder Time Stamping

The following figure demonstrates how the responder works. Four time stamps are taken to make the calculation for round-trip time. At the target router, with the responder functionality enabled, time stamp 2 (TS2) is subtracted from time stamp 3 (TS3) to produce the time spent processing the test packet as represented by delta. This delta value is then subtracted from the overall round-trip time. Notice that the same principle is applied by IP SLAs on the source router where the incoming time stamp 4 (TS4) is also taken at the interrupt level to allow for greater accuracy.



An additional benefit of the two time stamps at the target device is the ability to track one-way delay, jitter, and directional packet loss. Because much network behavior is asynchronous, it is critical to have these statistics. However, to capture one-way delay measurements, you must configure both the source router and target router with Network Time Protocol (NTP) so that the source and target are synchronized to the same clock source. One-way jitter measurements do not require clock synchronization.

IP SLAs Operation Scheduling

When you configure an IP SLAs operation, you must schedule the operation to begin capturing statistics and collecting error information. You can schedule an operation to start immediately or to start at a certain month, day, and hour. You can use the *pending* option to set the operation to start at a later time. The pending option is an internal state of the operation that is visible through SNMP. The pending state is also used when an operation is a reaction (threshold) operation waiting to be triggered. You can schedule a single IP SLAs operation or a group of operations at one time.

You can schedule several IP SLAs operations by using a single command through the Cisco IOS CLI or the CISCO RTTMON-MIB. Scheduling the operations to run at evenly distributed times allows you to control the amount of IP SLAs monitoring traffic. This distribution of IP SLA operations helps minimize the CPU utilization and thus improves network scalability.

For more details about the IP SLA multi-operations scheduling functionality, see the "IP SLAs—Multiple Operation Scheduling" chapter of the *Cisco IOS IP SLAs Configuration Guide*.

IP SLA Operation Threshold Monitoring

To support successful service level agreement monitoring, you must have mechanisms that notify you immediately of any possible violation. IP SLAs can send SNMP traps that are triggered by events such as the following:

- Connection loss
- Timeout
- Round-trip time threshold
- Average jitter threshold
- One-way packet loss
- One-way jitter
- One-way mean opinion score (MOS)
- One-way latency

An IP SLA threshold violation can also trigger another IP SLA operation for further analysis. For example, the frequency could be increased or an Internet Control Message Protocol (ICMP) path echo or ICMP path jitter operation could be initiated for troubleshooting.

ICMP Echo

The ICMP echo operation measures the end-to-end response time between a Cisco device and any other device that uses IP. The response time is computed by measuring the time it takes to send an ICMP echo request message to a destination and receive an ICMP echo reply. Many customers use IP SLA ICMP-based operations, in-house ping testing, or ping-based dedicated probes to measure this response time. The IP SLA ICMP echo operation conforms to the same specifications as ICMP ping testing, and both methods result in the same response times.

UDP Jitter

Jitter is a simple term that describes interpacket delay variance. When multiple packets are sent consecutively at an interval of 10 ms from source to destination, the destination should receive them 10 ms apart (if the network is behaving correctly). However, if there are delays in the network (such as queuing, arriving through alternate routes, and so on), the time interval between packet arrivals might be more or less than 10 ms. A positive jitter value indicates that the packets arrived more than 10 ms apart. A negative jitter value indicates that the packets arrived less than 10 ms apart. If the packets arrive 12 ms apart, the positive jitter is 2 ms; if the packets arrive 8 ms apart, the negative jitter is 2 ms. For delay-sensitive networks, positive jitter values are undesirable, and a jitter value of 0 is ideal.

In addition to monitoring jitter, the IP SLA UDP jitter operation can be used as a multipurpose data gathering operation. The packets generated by IP SLAs carry sequence information and time stamps from the source and operational target that include packet sending and receiving data. Based on this data, UDP jitter operations measure the following:

- Per-direction jitter (source to destination and destination to source)
- Per-direction packet-loss
- Per-direction delay (one-way delay)
- Round-trip delay (average round-trip time)

Because the paths for the sending and receiving of data can be different (asymmetric), you can use the per-direction data to more readily identify where congestion or other problems are occurring in the network.

The UDP jitter operation generates synthetic (simulated) UDP traffic and sends a number of UDP packets, each of a specified size, sent a specified number of milliseconds apart, from a source router to a target router, at a given frequency. By default, ten packet-frames, each with a payload size of 10 bytes are generated every 10 ms, and the operation is repeated every 60 seconds. You can configure each of these parameters to best simulate the IP service you want to provide.

To provide accurate one-way delay (latency) measurements, time synchronization (as provided by NTP) is required between the source and the target device. Time synchronization is not required for the one-way jitter and packet loss measurements. If the time is not synchronized between the source and target devices, one-way jitter and packet loss data is returned, but values of 0 are returned for the one-way delay measurements provided by the UDP jitter operation.

How to Configure IP SLAs Operations

This section does not include configuration information for all available operations as the configuration information details are included in the *Cisco IOS IP SLAs Configuration Guide*. It does include several operations as examples, including configuring the responder, configuring a UDP jitter operation, which requires a responder, and configuring an ICMP echo operation, which does not require a responder. For details about configuring other operations, see the *Cisco IOS IP SLAs Configuration Guide*.

Default Configuration

No IP SLAs operations are configured.

Configuration Guidelines

For information on the IP SLA commands, see the *Cisco IOS IP SLAs Command Reference, Release 12.4T* command reference.

For detailed descriptions and configuration procedures, see the *Cisco IOS IP SLAs Configuration Guide, Release 12.4TL*.

Not all of the IP SLA commands or operations described in the referenced guide are supported on the device. The device supports IP service level analysis by using UDP jitter, UDP echo, HTTP, TCP connect, ICMP echo, ICMP path echo, ICMP path jitter, FTP, DNS, and DHCP, as well as multiple operation scheduling and proactive threshold monitoring. It does not support VoIP service levels using the gatekeeper registration delay operations measurements.

Before configuring any IP SLAs application, you can use the **show ip sla application** privileged EXEC command to verify that the operation type is supported on your software image. This is an example of the output from the command:

```
Device# show ip sla application

        IP Service Level Agreements
Version: Round Trip Time MIB 2.2.0, Infrastructure Engine-III

Supported Operation Types:
        icmpEcho, path-echo, path-jitter, udpEcho, tcpConnect, http
        dns, udpJitter, dhcp, ftp, udpApp, wspApp

Supported Features:
        IPSLAs Event Publisher

IP SLAs low memory water mark: 33299323
Estimated system max number of entries: 24389

Estimated number of configurable operations: 24389
Number of Entries configured  : 0
Number of active Entries      : 0
Number of pending Entries     : 0
Number of inactive Entries    : 0
Time of last change in whole IP SLAs: *13:04:37.668 UTC Wed Dec 19 2012
```

Configuring the IP SLA Responder

The IP SLA responder is available only on Cisco IOS software-based devices, including some Layer 2 devices that do not support full IP SLA functionality.

Follow these steps to configure the IP SLA responder on the target device (the operational target):

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip sla responder** {**tcp-connect** | **udp-echo**} **ipaddress** *ip-address* **port** *port-number*
4. **end**
5. **show running-config**
6. **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**ip sla responder** {**tcp-connect** | **udp-echo**} **ipaddress** *ip-address* **port** *port-number* **Example:** `Device(config)# ip sla responder udp-echo 172.29.139.134 5000`	Configures the device as an IP SLA responder. The keywords have these meanings: • **tcp-connect**—Enables the responder for TCP connect operations. • **udp-echo**—Enables the responder for User Datagram Protocol (UDP) echo or jitter operations. • **ipaddress** *ip-address*—Enter the destination IP address. • **port** *port-number*—Enter the destination port number. **Note** The IP address and port number must match those configured on the source device for the IP SLA operation.
Step 4	**end** **Example:** `Device(config)# end`	Returns to privileged EXEC mode.
Step 5	**show running-config** **Example:** `Device# show running-config`	Verifies your entries.
Step 6	**copy running-config startup-config** **Example:** `Device# copy running-config startup-config`	(Optional) Saves your entries in the configuration file.

Implementing IP SLA Network Performance Measurement

Follow these steps to implement IP SLA network performance measurement on your device:

Before you begin

Use the **show ip sla application** privileged EXEC command to verify that the desired operation type is supported on your software image.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip sla** *operation-number*
4. **udp-jitter** {*destination-ip-address* | *destination-hostname*} *destination-port* [**source-ip** {*ip-address* | *hostname*}] [**source-port** *port-number*] [**control** {**enable** | **disable**}] [**num-packets** *number-of-packets*] [**interval** *interpacket-interval*]
5. **frequency** *seconds*
6. **threshold** *milliseconds*
7. **exit**
8. **ip sla schedule** *operation-number* [**life** {**forever** | *seconds*}] [**start-time** {*hh:mm* [*:ss*] [*month day* | *day month*] | **pending** | **now** | **after** *hh:mm:ss*] [**ageout** *seconds*] [**recurring**]
9. **end**
10. **show running-config**
11. **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**ip sla** *operation-number* **Example:** `Device(config)# ip sla 10`	Creates an IP SLA operation, and enters IP SLA configuration mode.
Step 4	**udp-jitter** {*destination-ip-address* | *destination-hostname*} *destination-port* [**source-ip** {*ip-address* | *hostname*}] [**source-port** *port-number*] [**control** {**enable** | **disable**}]	Configures the IP SLA operation as the operation type of your choice (a UDP jitter operation is used in the example), and enters its configuration mode (UDP jitter configuration mode is used in the example).

	Command or Action	Purpose
	[**num-packets** *number-of-packets*] [**interval** *interpacket-interval*] **Example:** `Device(config-ip-sla)# udp-jitter 172.29.139.134 5000 source-ip 172.29.139.140 source-port 4000`	• *destination-ip-address* | *destination-hostname*: Specifies the destination IP address or hostname. • *destination-port*: Specifies the destination port number in the range from 1 to 65535. • (Optional) **source-ip** {*ip-address* | *hostname*}: Specifies the source IP address or hostname. When a source IP address or hostname is not specified, IP SLA chooses the IP address nearest to the destination • (Optional) **source-port** *port-number*: Specifies the source port number in the range from 1 to 65535. When a port number is not specified, IP SLA chooses an available port. **Note** If the **udp-jitter** command does not have the source port configured, UDP chooses any random port for control packets. In case UDP chooses the reserved port 1967, it may result in high CPU utilisation by the IP SLA responder. • (Optional) **control**: Enables or disables sending of IP SLA control messages to the IP SLA responder. By default, IP SLA control messages are sent to the destination device to establish a connection with the IP SLA responder • (Optional) **num-packets** *number-of-packets*: Enters the number of packets to be generated. The range is 1 to 6000; the default is 10. • (Optional) **interval** *inter-packet-interval*: Enters the interval between sending packets in milliseconds. The range is 1 to 6000; the default value is 20 ms.
Step 5	**frequency** *seconds* **Example:** `Device(config-ip-sla-jitter)# frequency 45`	(Optional) Configures options for the SLA operation. This example sets the rate at which a specified IP SLA operation repeats. The range is from 1 to 604800 seconds; the default is 60 seconds.
Step 6	**threshold** *milliseconds* **Example:** `Device(config-ip-sla-jitter)# threshold 200`	(Optional) Configures threshold conditions. This example sets the threshold of the specified IP SLA operation to 200. The range is from 0 to 60000 milliseconds.

	Command or Action	Purpose
Step 7	**exit** **Example:** `Device(config-ip-sla-jitter)# exit`	Exits the SLA operation configuration mode (UDP jitter configuration mode in this example), and returns to global configuration mode.
Step 8	**ip sla schedule** *operation-number* [**life** {**forever** | *seconds*}] [**start-time** {*hh:mm* [:*ss*] [*month day* | *day month*] | **pending** | **now** | **after** *hh:mm:ss*] [**ageout** *seconds*] [**recurring**] **Example:** `Device(config)# ip sla schedule 10 start-time now life forever`	Configures the scheduling parameters for an individual IP SLA operation. • *operation-number*: Enter the RTR entry number. • (Optional) **life**: Sets the operation to run indefinitely (**forever**) or for a specific number of *seconds*. The range is from 0 to 2147483647. The default is 3600 seconds (1 hour). • (Optional) **start-time**: Enters the time for the operation to begin collecting information: To start at a specific time, enter the hour, minute, second (in 24-hour notation), and day of the month. If no month is entered, the default is the current month. Enter **pending** to select no information collection until a start time is selected. Enter **now** to start the operation immediately. Enter **after** *hh:mm:ss* to show that the operation should start after the entered time has elapsed. • (Optional) **ageout** *seconds*: Enter the number of seconds to keep the operation in memory when it is not actively collecting information. The range is 0 to 2073600 seconds, the default is 0 seconds (never ages out). • (Optional) **recurring**: Set the operation to automatically run every day.
Step 9	**end** **Example:** `Device(config)# end`	Returns to privileged EXEC mode.
Step 10	**show running-config** **Example:** `Device# show running-config`	Verifies your entries.
Step 11	**copy running-config startup-config** **Example:**	(Optional) Saves your entries in the configuration file.

	Command or Action	Purpose
	`Device# copy running-config startup-config`	

UDP Jitter Configuration

This example shows how to configure a UDP jitter IP SLA operation:

```
Device(config)# ip sla 10
Device(config-ip-sla)# udp-jitter 172.29.139.134 5000 source-ip 172.29.139.140 source-port
 4000
Device(config-ip-sla-jitter)# frequency 30
Device(config-ip-sla-jitter)# exit
Device(config)# ip sla schedule 10 start-time now life forever
Device(config)# end
Device# show ip sla configuration 10
IP SLAs, Infrastructure Engine-II.

Entry number: 10
Owner:
Tag:
Type of operation to perform: udp-jitter
Target address/Source address: 1.1.1.1/0.0.0.0
Target port/Source port: 2/0
Request size (ARR data portion): 32
Operation timeout (milliseconds): 5000
Packet Interval (milliseconds)/Number of packets: 20/10
Type Of Service parameters: 0x0
Verify data: No
Vrf Name:
Control Packets: enabled
Schedule:
    Operation frequency (seconds): 30
    Next Scheduled Start Time: Pending trigger
    Group Scheduled : FALSE
    Randomly Scheduled : FALSE
    Life (seconds): 3600
    Entry Ageout (seconds): never
    Recurring (Starting Everyday): FALSE
    Status of entry (SNMP RowStatus): notInService
Threshold (milliseconds): 5000
Distribution Statistics:
    Number of statistic hours kept: 2
    Number of statistic distribution buckets kept: 1
    Statistic distribution interval (milliseconds): 20
Enhanced History:
```

Analyzing IP Service Levels by Using the UDP Jitter Operation

Follow these steps to configure a UDP jitter operation on the source device:

Before you begin

You must enable the IP SLA responder on the target device (the operational target) to configure a UDP jitter operation on the source device.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip sla** *operation-number*
4. **udp-jitter** {*destination-ip-address* | *destination-hostname*} *destination-port* [**source-ip** {*ip-address* | *hostname*}] [**source-port** *port-number*] [**control** {**enable** | **disable**}] [**num-packets** *number-of-packets*] [**interval** *interpacket-interval*]
5. **frequency** *seconds*
6. **exit**
7. **ip sla schedule** *operation-number* [**life** {**forever** | *seconds*}] [**start-time** {*hh:mm* [:*ss*] [*month day* | *day month*] | **pending** | **now** | **after** *hh:mm:ss*] [**ageout** *seconds*] [**recurring**]
8. **end**
9. **show running-config**
10. **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**ip sla** *operation-number* **Example:** `Device(config)# ip sla 10`	Creates an IP SLA operation, and enters IP SLA configuration mode.
Step 4	**udp-jitter** {*destination-ip-address* | *destination-hostname*} *destination-port* [**source-ip** {*ip-address* | *hostname*}] [**source-port** *port-number*] [**control** {**enable** | **disable**}] [**num-packets** *number-of-packets*] [**interval** *interpacket-interval*] **Example:** `Device(config-ip-sla)# udp-jitter 172.29.139.134 5000 source-ip 172.29.139.140 source-port 4000`	Configures the IP SLA operation as a UDP jitter operation, and enters UDP jitter configuration mode. • *destination-ip-address* | *destination-hostname*: Specifies the destination IP address or hostname. • *destination-port*: Specifies the destination port number in the range from 1 to 65535. • (Optional) **source-ip** {*ip-address* | *hostname*}: Specifies the source IP address or hostname. When a source IP address or hostname is not specified, IP SLA chooses the IP address nearest to the destination.

	Command or Action	Purpose
		• (Optional) **source-port** *port-number*: Specifies the source port number in the range from 1 to 65535. When a port number is not specified, IP SLA chooses an available port. **Note** If the **udp-jitter** command does not have the source port configured, UDP chooses any random port for control packets. In case UDP chooses the reserved port 1967, it may result in high CPU utilisation by the IP SLA responder. • (Optional) **control**: Enables or disables sending of IP SLA control messages to the IP SLA responder. By default, IP SLA control messages are sent to the destination device to establish a connection with the IP SLA responder. • (Optional) **num-packets** *number-of-packets*: Enters the number of packets to be generated. The range is 1 to 6000; the default is 10. • (Optional) **interval** *inter-packet-interval*: Enters the interval between sending packets in milliseconds. The range is 1 to 6000; the default value is 20 ms.
Step 5	**frequency** *seconds* **Example:** `Device(config-ip-sla-jitter)# frequency 45`	(Optional) Sets the rate at which a specified IP SLA operation repeats. The range is from 1 to 604800 seconds; the default is 60 seconds.
Step 6	**exit** **Example:** `Device(config-ip-sla-jitter)# exit`	Exits UDP jitter configuration mode, and returns to global configuration mode.
Step 7	**ip sla schedule** *operation-number* [**life** {**forever** | *seconds*}] [**start-time** {*hh:mm* [:*ss*] [*month day* | *day month*] | **pending** | **now** | **after** *hh:mm:ss*] [**ageout** *seconds*] [**recurring**] **Example:** `Device(config)# ip sla schedule 10 start-time now life forever`	Configures the scheduling parameters for an individual IP SLA operation. • *operation-number*: Enter the RTR entry number. • (Optional) **life**: Sets the operation to run indefinitely (**forever**) or for a specific number of *seconds*. The range is from 0 to 2147483647. The default is 3600 seconds (1 hour). • (Optional) **start-time**: Enters the time for the operation to begin collecting information:

	Command or Action	Purpose
		To start at a specific time, enter the hour, minute, second (in 24-hour notation), and day of the month. If no month is entered, the default is the current month. Enter **pending** to select no information collection until a start time is selected. Enter **now** to start the operation immediately. Enter **after** *hh:mm:ss* to show that the operation should start after the entered time has elapsed. • (Optional) **ageout** *seconds*: Enter the number of seconds to keep the operation in memory when it is not actively collecting information. The range is 0 to 2073600 seconds, the default is 0 seconds (never ages out). • (Optional) **recurring**: Set the operation to automatically run every day.
Step 8	**end** **Example:** `Device(config)# end`	Returns to privileged EXEC mode.
Step 9	**show running-config** **Example:** `Device# show running-config`	Verifies your entries.
Step 10	**copy running-config startup-config** **Example:** `Device# copy running-config startup-config`	(Optional) Saves your entries in the configuration file.

Configuring a UDP Jitter IP SLA Operation

This example shows how to configure a UDP jitter IP SLA operation:

```
Device(config)# ip sla 10
Device(config-ip-sla)# udp-jitter 172.29.139.134 5000 source-ip 172.29.139.140 source-port
 4000
Device(config-ip-sla-jitter)# frequency 30
Device(config-ip-sla-jitter)# exit
Device(config)# ip sla schedule 10 start-time now life forever
Device(config)# end
```

```
Device# show ip sla configuration 10
IP SLAs, Infrastructure Engine-II.

Entry number: 10
Owner:
Tag:
Type of operation to perform: udp-jitter
Target address/Source address: 1.1.1.1/0.0.0.0
Target port/Source port: 2/0
Request size (ARR data portion): 32
Operation timeout (milliseconds): 5000
Packet Interval (milliseconds)/Number of packets: 20/10
Type Of Service parameters: 0x0
Verify data: No
Vrf Name:
Control Packets: enabled
Schedule:
    Operation frequency (seconds): 30
    Next Scheduled Start Time: Pending trigger
    Group Scheduled : FALSE
    Randomly Scheduled : FALSE
    Life (seconds): 3600
    Entry Ageout (seconds): never
    Recurring (Starting Everyday): FALSE
    Status of entry (SNMP RowStatus): notInService
Threshold (milliseconds): 5000
Distribution Statistics:
    Number of statistic hours kept: 2
    Number of statistic distribution buckets kept: 1
    Statistic distribution interval (milliseconds): 20
Enhanced History:
```

Analyzing IP Service Levels by Using the ICMP Echo Operation

Follow these steps to configure an ICMP echo operation on the source device:

Before you begin

This operation does not require the IP SLA responder to be enabled.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip sla** *operation-number*
4. **icmp-echo** {*destination-ip-address* | *destination-hostname*} [**source-ip** {*ip-address* | *hostname*} | **source-interface** *interface-id*]
5. **frequency** *seconds*
6. **exit**
7. **ip sla schedule** *operation-number* [**life** {**forever** | *seconds*}] [**start-time** {*hh:mm* [*:ss*] [*month day* | *day month*] | **pending** | **now** | **after** *hh:mm:ss*] [**ageout** *seconds*] [**recurring**]
8. **end**
9. **show running-config**
10. **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**ip sla** *operation-number* **Example:** `Device(config)# ip sla 10`	Creates an IP SLA operation and enters IP SLA configuration mode.
Step 4	**icmp-echo** {*destination-ip-address* | *destination-hostname*} [**source-ip** {*ip-address* | *hostname*} | **source-interface** *interface-id*] **Example:** `Device(config-ip-sla)# icmp-echo 172.29.139.134`	Configures the IP SLA operation as an ICMP Echo operation and enters ICMP echo configuration mode. • *destination-ip-address* | *destination-hostname*—Specifies the destination IP address or hostname. • (Optional) **source-ip** {*ip-address* | *hostname*}—Specifies the source IP address or hostname. When a source IP address or hostname is not specified, IP SLA chooses the IP address nearest to the destination. • (Optional) **source-interface** *interface-id*—Specifies the source interface for the operation.
Step 5	**frequency** *seconds* **Example:** `Device(config-ip-sla-echo)# frequency 30`	(Optional) Sets the rate at which a specified IP SLA operation repeats. The range is from 1 to 604800 seconds; the default is 60 seconds.
Step 6	**exit** **Example:** `Device(config-ip-sla-echo)# exit`	Exits UDP echo configuration mode, and returns to global configuration mode.
Step 7	**ip sla schedule** *operation-number* [**life** {**forever** | *seconds*}] [**start-time** {*hh:mm* [*:ss*] [*month day* | *day month*] | **pending** | **now** | **after** *hh:mm:ss*] [**ageout** *seconds*] [**recurring**]	Configures the scheduling parameters for an individual IP SLA operation. • *operation-number*—Enter the RTR entry number.

	Command or Action	Purpose
	Example: `Device(config)# ip sla schedule 10 start-time now life forever`	• (Optional) **life**—Sets the operation to run indefinitely (**forever**) or for a specific number of *seconds*. The range is from 0 to 2147483647. The default is 3600 seconds (1 hour) • (Optional) **start-time**—Enter the time for the operation to begin collecting information: To start at a specific time, enter the hour, minute, second (in 24-hour notation), and day of the month. If no month is entered, the default is the current month. Enter **pending** to select no information collection until a start time is selected. Enter **now** to start the operation immediately. Enter **after** *hh:mm:ss* to indicate that the operation should start after the entered time has elapsed. • (Optional) **ageout** *seconds*—Enter the number of seconds to keep the operation in memory when it is not actively collecting information. The range is 0 to 2073600 seconds; the default is 0 seconds (never ages out). • (Optional) **recurring**—Sets the operation to automatically run every day.
Step 8	**end** **Example:** `Device(config)# end`	Returns to privileged EXEC mode.
Step 9	**show running-config** **Example:** `Device# show running-config`	Verifies your entries.
Step 10	**copy running-config startup-config** **Example:** `Device# copy running-config startup-config`	(Optional) Saves your entries in the configuration file.

Configuring an ICMP Echo IP SLA Operation

This example shows how to configure an ICMP echo IP SLA operation:

```
Device(config)# ip sla 12
Device(config-ip-sla)# icmp-echo 172.29.139.134
Device(config-ip-sla-echo)# frequency 30
Device(config-ip-sla-echo)# exit
Device(config)# ip sla schedule 12 start-time now life forever
Device(config)# end
Device# show ip sla configuration 22
IP SLAs, Infrastructure Engine-II.

Entry number: 12
Owner:
Tag:
Type of operation to perform: echo
Target address: 2.2.2.2
Source address: 0.0.0.0
Request size (ARR data portion): 28
Operation timeout (milliseconds): 5000
Type Of Service parameters: 0x0
Verify data: No
Vrf Name:
Schedule:
    Operation frequency (seconds): 60
    Next Scheduled Start Time: Pending trigger
    Group Scheduled : FALSE
    Randomly Scheduled : FALSE
    Life (seconds): 3600
    Entry Ageout (seconds): never
    Recurring (Starting Everyday): FALSE
    Status of entry (SNMP RowStatus): notInService
Threshold (milliseconds): 5000
Distribution Statistics:
    Number of statistic hours kept: 2
    Number of statistic distribution buckets kept: 1
    Statistic distribution interval (milliseconds): 20
History Statistics:
    Number of history Lives kept: 0
    Number of history Buckets kept: 15
    History Filter Type: None
Enhanced History:
```

Monitoring IP SLA Operations

The following table describes the commands used to display IP SLA operation configurations and results:

Table 6: Monitoring IP SLA Operations

show ip sla application	Displays global information about Cisco IOS IP SLAs.
show ip sla authentication	Displays IP SLA authentication information.
show ip sla configuration [*entry-number*]	Displays configuration values including all defaults for all IP SLA operations or a specific operation.
show ip sla enhanced-history {**collection-statistics** | **distribution statistics**} [*entry-number*]	Displays enhanced history statistics for collected history buckets or distribution statistics for all IP SLA operations or a specific operation.

show ip sla ethernet-monitor configuration [*entry-number*]	Displays IP SLA automatic Ethernet configuration.
show ip sla group schedule [*schedule-entry-number*]	Displays IP SLA group scheduling configuration and details.
show ip sla history [*entry-number* | **full** | **tabular**]	Displays history collected for all IP SLA operations.
show ip sla mpls-lsp-monitor {**collection-statistics** | **configuration** | **ldp operational-state** | **scan-queue** | **summary** [*entry-number*] | **neighbors**}	Displays MPLS label switched path (LSP) Health Monitor operations.
show ip sla reaction-configuration [*entry-number*]	Displays the configured proactive threshold monitoring settings for all IP SLA operations or a specific operation.
show ip sla reaction-trigger [*entry-number*]	Displays the reaction trigger information for all IP SLA operations or a specific operation.
show ip sla responder	Displays information about the IP SLA responder.
show ip sla statistics [*entry-number* | **aggregated** | **details**]	Displays current or aggregated operational status and statistics.

Monitoring IP SLA Operation Examples

The following example shows all IP SLAs by application:

```
Device# show ip sla application

        IP Service Level Agreements
Version: Round Trip Time MIB 2.2.0, Infrastructure Engine-III

Supported Operation Types:
        icmpEcho, path-echo, path-jitter, udpEcho, tcpConnect, http
        dns, udpJitter, dhcp, ftp, udpApp, wspApp

Supported Features:
        IPSLAs Event Publisher

IP SLAs low memory water mark: 33299323
Estimated system max number of entries: 24389

Estimated number of configurable operations: 24389
Number of Entries configured  : 0
Number of active Entries      : 0
Number of pending Entries     : 0
Number of inactive Entries    : 0
Time of last change in whole IP SLAs: *13:04:37.668 UTC Wed Dec 19 2012
```

The following example shows all IP SLA distribution statistics:

```
Device# show ip sla enhanced-history distribution-statistics

Point by point Enhanced History
Entry    = Entry Number
Int      = Aggregation Interval
```

```
BucI     = Bucket Index
StartT   = Aggregation Start Time
Pth      = Path index
Hop      = Hop in path index
Comps    = Operations completed
OvrTh    = Operations completed over thresholds
SumCmp   = Sum of RTT (milliseconds)
SumCmp2L = Sum of RTT squared low 32 bits (milliseconds)
SumCmp2H = Sum of RTT squared high 32 bits (milliseconds)
TMax     = RTT maximum (milliseconds)
TMin     = RTT minimum (milliseconds)

Entry Int BucI StartT     Pth Hop Comps OvrTh SumCmp     SumCmp2L   SumCmp2H   T
Max    TMin
```

Additional References

Related Documents

Related Topic	Document Title
Cisco Medianet Metadata Guide	http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/mdata/configuration/15-sy/mdata-15sy-book/metadata-framework.pdf
Cisco Media Services Proxy Configuration Guide	http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/msp/configuration/15-mt/msp-15-mt-book.pdf
Cisco Mediatrace and Cisco Performance Monitor Configuration Guide	http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/media_monitoring/configuration/15-mt/mm-15-mt-book/mm-mediatrace.html

Error Message Decoder

Description	Link
To help you research and resolve system error messages in this release, use the Error Message Decoder tool.	https://www.cisco.com/cgi-bin/Support/Errordecoder/index.cgi

Standards and RFCs

Standard/RFC	Title
None	-

MIBs

MIB	MIBs Link
All supported MIBs for this release.	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

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/support

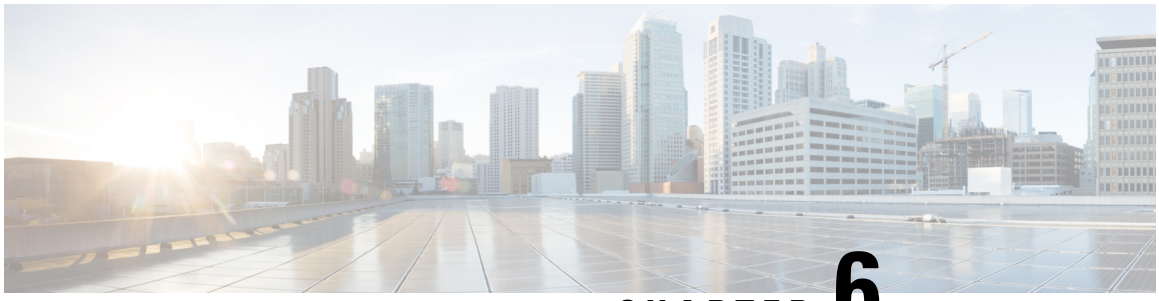
Feature Information for Service Level Agreements

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Table 7: Feature Information for Service Level Agreements

Releases	Feature Information
Cisco IOS XE Fuji 16.9.2	This feature was introduced.



CHAPTER 6

Configuring SPAN and RSPAN

Prerequisites for SPAN and RSPAN

SPAN

- You can limit SPAN traffic to specific VLANs by using the **filter vlan** keyword. If a trunk port is being monitored, only traffic on the VLANs specified with this keyword is monitored. By default, all VLANs are monitored on a trunk port.

RSPAN

- We recommend that you configure an RSPAN VLAN before you configure an RSPAN source or a destination session.

Restrictions for SPAN and RSPAN

SPAN

The restrictions for SPAN are as follows:

- For SPAN sources, you can monitor traffic for a single port or VLAN or a series or range of ports or VLANs for each session. You cannot mix source ports and source VLANs within a single SPAN session.
- The destination port cannot be a source port; a source port cannot be a destination port.
- You cannot have two SPAN sessions using the same destination port.

- When you configure a device port as a SPAN destination port, it is no longer a normal device port; only monitored traffic passes through the SPAN destination port.
- Entering SPAN configuration commands does not remove previously configured SPAN parameters. You must enter the **no monitor session** {*session_number* | **all** | **local** | **remote**} global configuration command to delete configured SPAN parameters.
- For local SPAN, outgoing packets through the SPAN destination port carry the original encapsulation headers—untagged, ISL, or IEEE 802.1Q—if the **encapsulation replicate** keywords are specified. If the keywords are not specified, the packets are sent in native form.
- You can configure a disabled port to be a source or destination port, but the SPAN function does not start until the destination port and at least one source port or source VLAN are enabled.
- You cannot mix source VLANs and filter VLANs within a single SPAN session.

Traffic monitoring in a SPAN session has the following restrictions:

- Sources can be ports or VLANs, but you cannot mix source ports and source VLANs in the same session.
- Wireshark does not capture egress packets when egress span is active.
- You can run both a local SPAN and an RSPAN source session in the same device or device stack. The device or device stack supports a total of 66 source and RSPAN destination sessions.
- You can configure two separate SPAN or RSPAN source sessions with separate or overlapping sets of SPAN source ports and VLANs. Both switched and routed ports can be configured as SPAN sources and destinations.
- You can have multiple destination ports in a SPAN session, but no more than 64 destination ports per device stack.
- SPAN sessions do not interfere with the normal operation of the device. However, an oversubscribed SPAN destination, for example, a 10-Mb/s port monitoring a 100-Mb/s port, can result in dropped or lost packets.
- When SPAN or RSPAN is enabled, each packet being monitored is sent twice, once as normal traffic and once as a monitored packet. Monitoring a large number of ports or VLANs could potentially generate large amounts of network traffic.
- You can configure SPAN sessions on disabled ports; however, a SPAN session does not become active unless you enable the destination port and at least one source port or VLAN for that session.
- The device does not support a combination of local SPAN and RSPAN in a single session.
  - An RSPAN source session cannot have a local destination port.
  - An RSPAN destination session cannot have a local source port.
  - An RSPAN destination session and an RSPAN source session that are using the same RSPAN VLAN cannot run on the same device or device stack.
- SPAN sessions capture only Dynamic Host Configuration Protocol (DHCP) ingress packets when DHCP snooping is enabled on the device.

RSPAN

The restrictions for RSPAN are as follows:

- RSPAN does not support BPDU packet monitoring or other Layer 2 device protocols.
- The RSPAN VLAN is configured only on trunk ports and not on access ports. To avoid unwanted traffic in RSPAN VLANs, make sure that the VLAN remote-span feature is supported in all the participating devices.
- RSPAN VLANs are included as sources for port-based RSPAN sessions when source trunk ports have active RSPAN VLANs. RSPAN VLANs can also be sources in SPAN sessions. However, since the device does not monitor spanned traffic, it does not support egress spanning of packets on any RSPAN VLAN identified as the destination of an RSPAN source session on the device.
- If you enable VTP and VTP pruning, RSPAN traffic is pruned in the trunks to prevent the unwanted flooding of RSPAN traffic across the network for VLAN IDs that are lower than 1005.
- It is recommended not to configure RSPAN VLAN as Native VLAN.

Information About SPAN and RSPAN

SPAN and RSPAN

You can analyze network traffic passing through ports or VLANs by using SPAN or RSPAN to send a copy of the traffic to another port on the device or on another device that has been connected to a network analyzer or other monitoring or security device. SPAN copies (or mirrors) traffic received or sent (or both) on source ports or source VLANs to a destination port for analysis. SPAN does not affect the switching of network traffic on the source ports or VLANs. You must dedicate the destination port for SPAN use. Except for traffic that is required for the SPAN or RSPAN session, destination ports do not receive or forward traffic.

Only traffic that enters or leaves source ports or traffic that enters or leaves source VLANs can be monitored by using SPAN; traffic routed to a source VLAN cannot be monitored. For example, if incoming traffic is being monitored, traffic that gets routed from another VLAN to the source VLAN cannot be monitored; however, traffic that is received on the source VLAN and routed to another VLAN can be monitored.

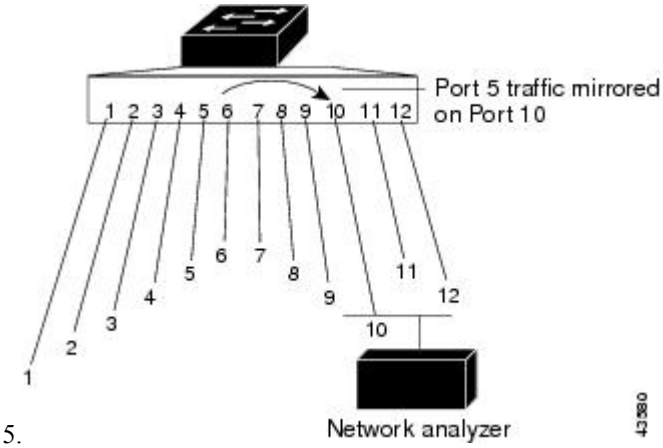
You can use the SPAN or RSPAN destination port to inject traffic from a network security device. For example, if you connect a Cisco Intrusion Detection System (IDS) sensor appliance to a destination port, the IDS device can send TCP reset packets to close down the TCP session of a suspected attacker.

Local SPAN

Local SPAN supports a SPAN session entirely within one device; all source ports or source VLANs and destination ports are in the same device or device stack. Local SPAN copies traffic from one or more source ports in any VLAN or from one or more VLANs to a destination port for analysis.

Figure 5: Example of Local SPAN Configuration on a Single Device

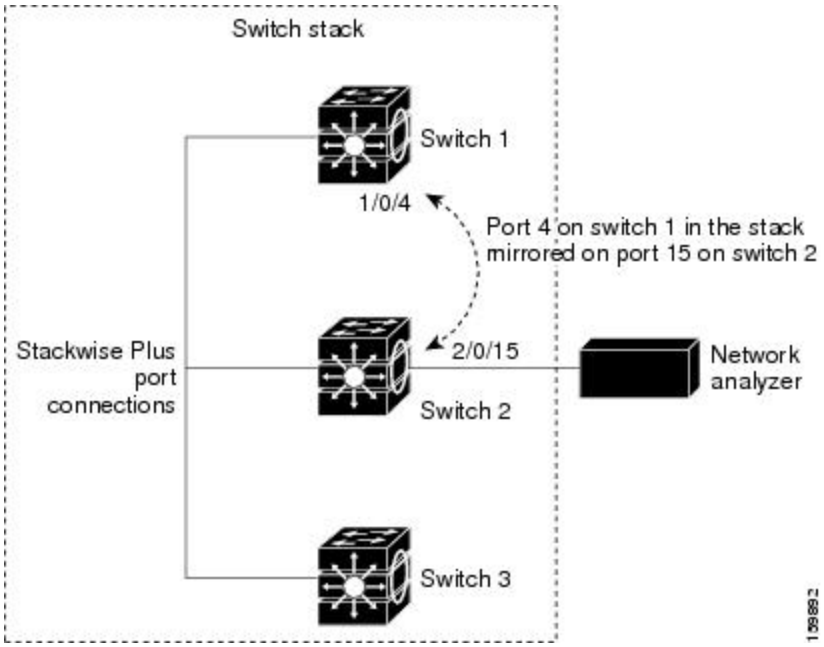
All traffic on port 5 (the source port) is mirrored to port 10 (the destination port). A network analyzer on port 10 receives all network traffic from port 5 without being physically attached to port



5.

Figure 6: Example of Local SPAN Configuration on a Device Stack

This is an example of a local SPAN in a device stack, where the source and destination ports reside on different stack members.



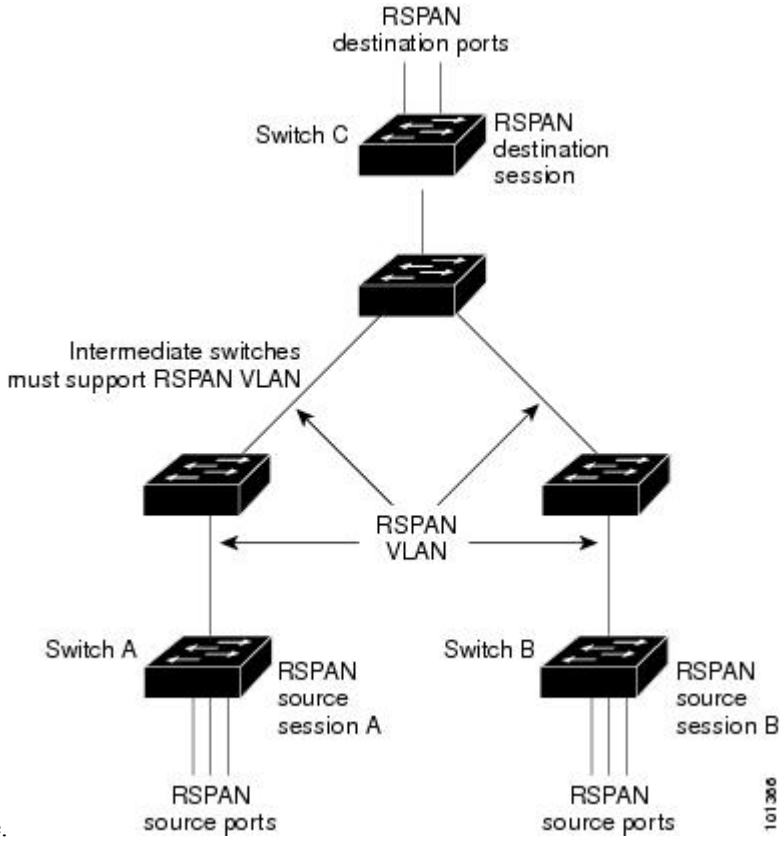
Remote SPAN

RSPAN supports source ports, source VLANs, and destination ports on different devices (or different device stacks), enabling remote monitoring of multiple devices across your network.

Figure 7: Example of RSPAN Configuration

The figure below shows source ports on Device A and Device B. The traffic for each RSPAN session is carried over a user-specified RSPAN VLAN that is dedicated for that RSPAN session in all participating devices.

The RSPAN traffic from the source ports or VLANs is copied into the RSPAN VLAN and forwarded over trunk ports carrying the RSPAN VLAN to a destination session monitoring the RSPAN VLAN. Each RSPAN source device must have either ports or VLANs as RSPAN sources. The destination is always a physical port, as shown on Device C in the figure.



SPAN and RSPAN Concepts and Terminology

SPAN Sessions

SPAN sessions (local or remote) allow you to monitor traffic on one or more ports, or one or more VLANs, and send the monitored traffic to one or more destination ports.

A local SPAN session is an association of a destination port with source ports or source VLANs, all on a single network device. Local SPAN does not have separate source and destination sessions. Local SPAN sessions gather a set of ingress and egress packets specified by the user and form them into a stream of SPAN data, which is directed to the destination port.

RSPAN consists of at least one RSPAN source session, an RSPAN VLAN, and at least one RSPAN destination session. You separately configure RSPAN source sessions and RSPAN destination sessions on different network devices. To configure an RSPAN source session on a device, you associate a set of source ports or source VLANs with an RSPAN VLAN. The output of this session is the stream of SPAN packets that are sent to the RSPAN VLAN. To configure an RSPAN destination session on another device, you associate the destination port with the RSPAN VLAN. The destination session collects all RSPAN VLAN traffic and sends it out the RSPAN destination port.

An RSPAN source session is very similar to a local SPAN session, except for where the packet stream is directed. In an RSPAN source session, SPAN packets are relabeled with the RSPAN VLAN ID and directed over normal trunk ports to the destination device.

An RSPAN destination session takes all packets received on the RSPAN VLAN, strips off the VLAN tagging, and presents them on the destination port. The session presents a copy of all RSPAN VLAN packets (except Layer 2 control packets) to the user for analysis.

Traffic monitoring in a SPAN session has these restrictions:

- Sources can be ports or VLANs, but you cannot mix source ports and source VLANs in the same session.
- You can run both a local SPAN and an RSPAN source session in the same device or device stack. The device or device stack supports a total of 66 source and RSPAN destination sessions.
- You can configure two separate SPAN or RSPAN source sessions with separate or overlapping sets of SPAN source ports and VLANs. Both switched and routed ports can be configured as SPAN sources and destinations.
- You can have multiple destination ports in a SPAN session, but no more than 64 destination ports per device stack.
- SPAN sessions do not interfere with the normal operation of the device. However, an oversubscribed SPAN destination, for example, a 10-Mb/s port monitoring a 100-Mb/s port, can result in dropped or lost packets.
- When SPAN or RSPAN is enabled, each packet being monitored is sent twice, once as normal traffic and once as a monitored packet. Therefore monitoring a large number of ports or VLANs could potentially generate large amounts of network traffic.
- You can configure SPAN sessions on disabled ports; however, a SPAN session does not become active unless you enable the destination port and at least one source port or VLAN for that session.
- The device does not support a combination of local SPAN and RSPAN in a single session.
  - An RSPAN source session cannot have a local destination port.
  - An RSPAN destination session cannot have a local source port.
  - An RSPAN destination session and an RSPAN source session that are using the same RSPAN VLAN cannot run on the same device or device stack.

Monitored Traffic

SPAN sessions can monitor these traffic types:

- Receive (Rx) SPAN—Receive (or ingress) SPAN monitors as much as possible all of the packets received by the source interface or VLAN before any modification or processing is performed by the device. A copy of each packet received by the source is sent to the destination port for that SPAN session.

  Packets that are modified because of routing or Quality of Service (QoS)—for example, modified Differentiated Services Code Point (DSCP)—are copied before modification.

  Features that can cause a packet to be dropped during receive processing have no effect on ingress SPAN; the destination port receives a copy of the packet even if the actual incoming packet is dropped. These features include IP standard and extended input Access Control Lists (ACLs), ingress QoS policing, VLAN ACLs, and egress QoS policing.
- Transmit (Tx) SPAN—Transmit (or egress) SPAN monitors as much as possible all of the packets sent by the source interface after all modification and processing is performed by the device. A copy of each packet sent by the source is sent to the destination port for that SPAN session. The copy is provided after the packet is modified.

Packets that are modified because of routing (for example, with modified time-to-live (TTL), MAC address, or QoS values) are duplicated (with the modifications) at the destination port.

Features that can cause a packet to be dropped during transmit processing also affect the duplicated copy for SPAN. These features include IP standard and extended output ACLs and egress QoS policing.

- Both—In a SPAN session, you can also monitor a port or VLAN for both received and sent packets. This is the default.

Therefore, a local SPAN session with encapsulation replicate enabled can have a mixture of untagged and IEEE 802.1Q tagged packets appear on the destination port.

Device congestion can cause packets to be dropped at ingress source ports, egress source ports, or SPAN destination ports. In general, these characteristics are independent of one another. For example:

- A packet might be forwarded normally but dropped from monitoring due to an oversubscribed SPAN destination port.
- An ingress packet might be dropped from normal forwarding, but still appear on the SPAN destination port.
- An egress packet dropped because of device congestion is also dropped from egress SPAN.

In some SPAN configurations, multiple copies of the same source packet are sent to the SPAN destination port. For example, a bidirectional (both Rx and Tx) SPAN session is configured for the Rx monitor on port A and Tx monitor on port B. If a packet enters the device through port A and is switched to port B, both incoming and outgoing packets are sent to the destination port. Both packets are the same unless a Layer 3 rewrite occurs, in which case the packets are different because of the packet modification.

Source Ports

A source port (also called a monitored port) is a switched or routed port that you monitor for network traffic analysis.

In a local SPAN session or RSPAN source session, you can monitor source ports or VLANs for traffic in one or both directions.

The device supports any number of source ports (up to the maximum number of available ports on the device) and any number of source VLANs (up to the maximum number of VLANs supported).

You cannot mix ports and VLANs in a single session.

A source port has these characteristics:

- It can be monitored in multiple SPAN sessions.
- Each source port can be configured with a direction (ingress, egress, or both) to monitor.
- It can be any port type (for example, EtherChannel, Gigabit Ethernet, and so forth).
- For EtherChannel sources, you can monitor traffic for the entire EtherChannel or individually on a physical port as it participates in the port channel.
- It can be an access port, trunk port, routed port, or voice VLAN port.
- It cannot be a destination port.
- Source ports can be in the same or different VLANs.
- You can monitor multiple source ports in a single session.

Source VLANs

VLAN-based SPAN (VSPAN) is the monitoring of the network traffic in one or more VLANs. The SPAN or RSPAN source interface in VSPAN is a VLAN ID, and traffic is monitored on all the ports for that VLAN.

VSPAN has these characteristics:

- All active ports in the source VLAN are included as source ports and can be monitored in either or both directions.
- On a given port, only traffic on the monitored VLAN is sent to the destination port.
- If a destination port belongs to a source VLAN, it is excluded from the source list and is not monitored.
- If ports are added to or removed from the source VLANs, the traffic on the source VLAN received by those ports is added to or removed from the sources being monitored.
- You cannot use filter VLANs in the same session with VLAN sources.
- You can monitor only Ethernet VLANs.

VLAN Filtering

When you monitor a trunk port as a source port, by default, all VLANs active on the trunk are monitored. You can limit SPAN traffic monitoring on trunk source ports to specific VLANs by using VLAN filtering.

- VLAN filtering applies only to trunk ports or to voice VLAN ports.
- VLAN filtering applies only to port-based sessions and is not allowed in sessions with VLAN sources.
- When a VLAN filter list is specified, only those VLANs in the list are monitored on trunk ports or on voice VLAN access ports.
- SPAN traffic coming from other port types is not affected by VLAN filtering; that is, all VLANs are allowed on other ports.
- VLAN filtering affects only traffic forwarded to the destination SPAN port and does not affect the switching of normal traffic.

Destination Port

Each local SPAN session or RSPAN destination session must have a destination port (also called a monitoring port) that receives a copy of traffic from the source ports or VLANs and sends the SPAN packets to the user, usually a network analyzer.

A destination port has these characteristics:

- For a local SPAN session, the destination port must reside on the same device or device stack as the source port. For an RSPAN session, it is located on the device containing the RSPAN destination session. There is no destination port on a device or device stack running only an RSPAN source session.
- When a port is configured as a SPAN destination port, the configuration overwrites the original port configuration. When the SPAN destination configuration is removed, the port reverts to its previous configuration. If a configuration change is made to the port while it is acting as a SPAN destination port, the change does not take effect until the SPAN destination configuration had been removed.
- If the port was in an EtherChannel group, it is removed from the group while it is a destination port. If it was a routed port, it is no longer a routed port.

- It can be any Ethernet physical port.
- It cannot be a secure port.
- It cannot be a source port.
- It can be an EtherChannel group (**ON** mode only).
- It can participate in only one SPAN session at a time (a destination port in one SPAN session cannot be a destination port for a second SPAN session).
- When it is active, incoming traffic is disabled. The port does not transmit any traffic except that required for the SPAN session. Incoming traffic is never learned or forwarded on a destination port.
- If ingress traffic forwarding is enabled for a network security device, the destination port forwards traffic at Layer 2.
- It does not participate in any of the Layer 2 protocols (STP, VTP, CDP, DTP, PagP).
- A destination port that belongs to a source VLAN of any SPAN session is excluded from the source list and is not monitored.
- The maximum number of destination ports in a device or device stack is 64.

Local SPAN and RSPAN destination ports function differently with VLAN tagging and encapsulation:

- For local SPAN, if the **encapsulation replicate** keywords are specified for the destination port, these packets appear with the original encapsulation (untagged, ISL, or IEEE 802.1Q). If these keywords are not specified, packets appear in the untagged format. Therefore, the output of a local SPAN session with **encapsulation replicate** enabled can contain a mixture of untagged, ISL, or IEEE 802.1Q-tagged packets.
- For RSPAN, the original VLAN ID is lost because it is overwritten by the RSPAN VLAN identification. Therefore, all packets appear on the destination port as untagged.

RSPAN VLAN

The RSPAN VLAN carries SPAN traffic between RSPAN source and destination sessions. RSPAN VLAN has these special characteristics:

- All traffic in the RSPAN VLAN is always flooded.
- No MAC address learning occurs on the RSPAN VLAN.
- RSPAN VLAN traffic only flows on trunk ports.
- RSPAN VLANs must be configured in VLAN configuration mode by using the **remote-span** VLAN configuration mode command.
- STP can run on RSPAN VLAN trunks but not on SPAN destination ports.
- An RSPAN VLAN cannot be a private-VLAN primary or secondary VLAN.

For VLANs 1 to 1005 that are visible to VLAN Trunking Protocol (VTP), the VLAN ID and its associated RSPAN characteristic are propagated by VTP. If you assign an RSPAN VLAN ID in the extended VLAN range (1006 to 4094), you must manually configure all intermediate devices.

It is normal to have multiple RSPAN VLANs in a network at the same time with each RSPAN VLAN defining a network-wide RSPAN session. That is, multiple RSPAN source sessions anywhere in the network can

contribute packets to the RSPAN session. It is also possible to have multiple RSPAN destination sessions throughout the network, monitoring the same RSPAN VLAN and presenting traffic to the user. The RSPAN VLAN ID separates the sessions.

SPAN and RSPAN Interaction with Other Features

SPAN interacts with these features:

- Routing—SPAN does not monitor routed traffic. VSPAN only monitors traffic that enters or exits the device, not traffic that is routed between VLANs. For example, if a VLAN is being Rx-monitored and the device routes traffic from another VLAN to the monitored VLAN, that traffic is not monitored and not received on the SPAN destination port.
- STP—A destination port does not participate in STP while its SPAN or RSPAN session is active. The destination port can participate in STP after the SPAN or RSPAN session is disabled. On a source port, SPAN does not affect the STP status. STP can be active on trunk ports carrying an RSPAN VLAN.
- CDP—A SPAN destination port does not participate in CDP while the SPAN session is active. After the SPAN session is disabled, the port again participates in CDP.
- VTP—You can use VTP to prune an RSPAN VLAN between devices.
- VLAN and trunking—You can modify VLAN membership or trunk settings for source or destination ports at any time. However, changes in VLAN membership or trunk settings for a destination port do not take effect until you remove the SPAN destination configuration. Changes in VLAN membership or trunk settings for a source port immediately take effect, and the respective SPAN sessions automatically adjust accordingly.
- EtherChannel—You can configure an EtherChannel group as a source port . When a group is configured as a SPAN source, the entire group is monitored.

  If a physical port is added to a monitored EtherChannel group, the new port is added to the SPAN source port list. If a port is removed from a monitored EtherChannel group, it is automatically removed from the source port list.

  A physical port that belongs to an EtherChannel group can be configured as a SPAN source port and still be a part of the EtherChannel. In this case, data from the physical port is monitored as it participates in the EtherChannel. However, if a physical port that belongs to an EtherChannel group is configured as a SPAN destination, it is removed from the group. After the port is removed from the SPAN session, it rejoins the EtherChannel group. Ports removed from an EtherChannel group remain members of the group, but they are in the inactive or suspended state.

  If a physical port that belongs to an EtherChannel group is a destination port and the EtherChannel group is a source, the port is removed from the EtherChannel group and from the list of monitored ports.
- Multicast traffic can be monitored. For egress and ingress port monitoring, only a single unedited packet is sent to the SPAN destination port. It does not reflect the number of times the multicast packet is sent.
- A private-VLAN port cannot be a SPAN destination port.
- A secure port cannot be a SPAN destination port.

  For SPAN sessions, do not enable port security on ports with monitored egress when ingress forwarding is enabled on the destination port. For RSPAN source sessions, do not enable port security on any ports with monitored egress.

- An IEEE 802.1x port can be a SPAN source port. You can enable IEEE 802.1x on a port that is a SPAN destination port; however, IEEE 802.1x is disabled until the port is removed as a SPAN destination.

  For SPAN sessions, do not enable IEEE 802.1x on ports with monitored egress when ingress forwarding is enabled on the destination port. For RSPAN source sessions, do not enable IEEE 802.1x on any ports that are egress monitored.

SPAN and RSPAN and Device Stacks

Because the stack of devices represents one logical device, local SPAN source ports and destination ports can be in different devices in the stack. Therefore, the addition or deletion of devices in the stack can affect a local SPAN session, as well as an RSPAN source or destination session. An active session can become inactive when a device is removed from the stack or an inactive session can become active when a device is added to the stack.

Flow-Based SPAN

You can control the type of network traffic to be monitored in SPAN or RSPAN sessions by using flow-based SPAN (FSPAN) or flow-based RSPAN (FRSPAN), which apply access control lists (ACLs) to the monitored traffic on the source ports. The FSPAN ACLs can be configured to filter IPv4, IPv6, and non-IP monitored traffic.

You apply an ACL to a SPAN session through the interface. It is applied to all the traffic that is monitored on all interfaces in the SPAN session.The packets that are permitted by this ACL are copied to the SPAN destination port. No other packets are copied to the SPAN destination port.

The original traffic continues to be forwarded, and any port, VLAN, and router ACLs attached are applied. The FSPAN ACL does not have any effect on the forwarding decisions. Similarly, the port, VLAN, and router ACLs do not have any effect on the traffic monitoring. If a security input ACL denies a packet and it is not forwarded, the packet is still copied to the SPAN destination ports if the FSPAN ACL permits it. But if the security output ACL denies a packet and it is not sent, it is not copied to the SPAN destination ports. However, if the security output ACL permits the packet to go out, it is only copied to the SPAN destination ports if the FSPAN ACL permits it. This is also true for an RSPAN session.

You can attach three types of FSPAN ACLs to the SPAN session:

- IPv4 FSPAN ACL— Filters only IPv4 packets.
- IPv6 FSPAN ACL— Filters only IPv6 packets.
- MAC FSPAN ACL— Filters only non-IP packets.

If a VLAN-based FSPAN session configured on a stack cannot fit in the hardware memory on one or more devices, it is treated as unloaded on those devices, and traffic meant for the FSPAN ACL and sourcing on that device is not copied to the SPAN destination ports. The FSPAN ACL continues to be correctly applied, and traffic is copied to the SPAN destination ports on the devices where the FSPAN ACL fits in the hardware memory.

When an empty FSPAN ACL is attached, some hardware functions copy all traffic to the SPAN destination ports for that ACL. If sufficient hardware resources are not available, even an empty FSPAN ACL can be unloaded.

Default SPAN and RSPAN Configuration

Table 8: Default SPAN and RSPAN Configuration

Feature	Default Setting
SPAN state (SPAN and RSPAN)	Disabled.
Source port traffic to monitor	Both received and sent traffic (**both**).
Encapsulation type (destination port)	Native form (untagged packets).
Ingress forwarding (destination port)	Disabled.
VLAN filtering	On a trunk interface used as a source port, all VLANs are monitored.
RSPAN VLANs	None configured.

Configuration Guidelines

SPAN Configuration Guidelines

- To remove a source or destination port or VLAN from the SPAN session, use the **no monitor session** *session_number* **source** {**interface** *interface-id* | **vlan** *vlan-id*} global configuration command or the **no monitor session** *session_number* **destination interface** *interface-id* global configuration command. For destination interfaces, the **encapsulation** options are ignored with the **no** form of the command.
- To monitor all VLANs on the trunk port, use the **no monitor session** *session_number* **filter** global configuration command.

RSPAN Configuration Guidelines

- All the SPAN configuration guidelines apply to RSPAN.
- As RSPAN VLANs have special properties, you should reserve a few VLANs across your network for use as RSPAN VLANs; do not assign access ports to these VLANs.
- You can apply an output ACL to RSPAN traffic to selectively filter or monitor specific packets. Specify these ACLs on the RSPAN VLAN in the RSPAN source devices.
- For RSPAN configuration, you can distribute the source ports and the destination ports across multiple devices in your network.
- Access ports (including voice VLAN ports) on the RSPAN VLAN are put in the inactive state.
- You can configure any VLAN as an RSPAN VLAN as long as these conditions are met:
  - The same RSPAN VLAN is used for an RSPAN session in all the devices.
  - All participating devices support RSPAN.

FSPAN and FRSPAN Configuration Guidelines

- When at least one FSPAN ACL is attached, FSPAN is enabled.
- When you attach at least one FSPAN ACL that is not empty to a SPAN session, and you have not attached one or more of the other FSPAN ACLs (for instance, you have attached an IPv4 ACL that is not empty, and have not attached IPv6 and MAC ACLs), FSPAN blocks the traffic that would have been filtered by the unattached ACLs. Therefore, this traffic is not monitored.

How to Configure SPAN and RSPAN

Creating a Local SPAN Session

Follow these steps to create a SPAN session and specify the source (monitored) ports or VLANs and the destination (monitoring) ports.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **no monitor session** {*session_number* | **all** | **local** | **remote**}
4. **monitor session** *session_number* **source** {**interface** *interface-id* | **vlan** *vlan-id*} [**,** | **-**] [**both** | **rx** | **tx**]
5. **monitor session** *session_number* **destination** {**interface** *interface-id* [**,** | **-**] [**encapsulation {replicate | dot1q}**]}
6. **end**
7. **show running-config**
8. **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**no monitor session** {*session_number* | **all** | **local** | **remote**} **Example:** `Device(config)# no monitor session all`	Removes any existing SPAN configuration for the session. • For *session_number*, the range is 1 to 66. • **all**—Removes all SPAN sessions. • **local**—Removes all local sessions.

	Command or Action	Purpose
		• **remote**—Removes all remote SPAN sessions.
Step 4	**monitor session** *session_number* **source** {**interface** *interface-id* | **vlan** *vlan-id*} [**,** | **-**] [**both** | **rx** | **tx**] **Example:** `Device(config)# monitor session 1 source interface gigabitethernet1/0/1`	Specifies the SPAN session and the source port (monitored port). • For *session_number*, the range is 1 to 66. • For *interface-id*, specify the source port to monitor. Valid interfaces include physical interfaces and port-channel logical interfaces (**port-channel** *port-channel-number*). Valid port-channel numbers are 1 to 48. • For *vlan-id*, specify the source VLAN to monitor. The range is 1 to 4094 (excluding the RSPAN VLAN). **Note** A single session can include multiple sources (ports or VLANs) defined in a series of commands, but you cannot combine source ports and source VLANs in one session. • (Optional) [**,** | **-**] Specifies a series or range of interfaces. Enter a space before and after the comma; enter a space before and after the hyphen. • (Optional) **both** | **rx** | **tx**—Specifies the direction of traffic to monitor. If you do not specify a traffic direction, the source interface sends both sent and received traffic. • **both**—Monitors both received and sent traffic. • **rx**—Monitors received traffic. • **tx**—Monitors sent traffic. **Note** You can use the **monitor session** *session_number* **source** command multiple times to configure multiple source ports.
Step 5	**monitor session** *session_number* **destination** {**interface** *interface-id* [**,** | **-**] [**encapsulation {replicate | dot1q}**]} **Example:** `Device(config)# monitor session 1 destination interface gigabitethernet1/0/2 encapsulation replicate`	Specifies the SPAN session and the destination port (monitoring port). The port LED changes to amber when the configuration changes take effect. The LED returns to its original state (green) only after removing the SPAN destination configuration. **Note** For local SPAN, you must use the same session number for the source and destination interfaces.

	Command or Action	Purpose
		• For *session_number*, specify the session number entered in step 4. • For *interface-id*, specify the destination port. The destination interface must be a physical port; it cannot be an EtherChannel, and it cannot be a VLAN. • (Optional) [**,** | -] Specifies a series or range of interfaces. Enter a space before and after the comma; enter a space before and after the hyphen. (Optional) **encapsulation replicate** specifies that the destination interface replicates the source interface encapsulation method. If not selected, the default is to send packets in native form (untagged). (Optional) **encapsulation dot1q**specifies that the destination interface accepts the source interface incoming packets with IEEE 802.1Q encapsulation. **Note** You can use **monitor session** *session_number* **destination** command multiple times to configure multiple destination ports.
Step 6	**end** **Example:** `Device(config)# end`	Returns to privileged EXEC mode.
Step 7	**show running-config** **Example:** `Device# show running-config`	Verifies your entries.
Step 8	**copy running-config startup-config** **Example:** `Device# copy running-config startup-config`	(Optional) Saves your entries in the configuration file.

Creating a Local SPAN Session and Configuring Incoming Traffic

Follow these steps to create a SPAN session, to specify the source ports or VLANs and the destination ports, and to enable incoming traffic on the destination port for a network security device (such as a Cisco IDS Sensor Appliance).

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **no monitor session** {*session_number* | **all** | **local** | **remote**}
4. **monitor session** *session_number* **source** {**interface** *interface-id* | **vlan** *vlan-id*} [**,** | **-**] [**both** | **rx** | **tx**]
5. **monitor session** *session_number* **destination** {**interface** *interface-id* [**,** | **-**] [**encapsulation replicate**[**ingress** {**dot1q vlan** *vlan-id* **| untagged vlan** *vlan-id* **| vlan** *vlan-id*}]}
6. **end**
7. **show running-config**
8. **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**no monitor session** {*session_number* | **all** | **local** | **remote**} **Example:** `Device(config)# no monitor session all`	Removes any existing SPAN configuration for the session. • For *session_number*, the range is 1 to 4. • **all**—Removes all SPAN sessions. • **local**—Removes all local sessions. • **remote**—Removes all remote SPAN sessions.
Step 4	**monitor session** *session_number* **source** {**interface** *interface-id* | **vlan** *vlan-id*} [**,** | **-**] [**both** | **rx** | **tx**] **Example:** `Device(config)# monitor session 2 source gigabitethernet0/1 rx`	Specifies the SPAN session and the source port (monitored port).
Step 5	**monitor session** *session_number* **destination** {**interface** *interface-id* [**,** | **-**] [**encapsulation replicate**[**ingress** {**dot1q vlan** *vlan-id* **| untagged vlan** *vlan-id* **| vlan** *vlan-id*}]} **Example:** `Device(config)# monitor session 2 destination`	Specifies the SPAN session, the destination port, the packet encapsulation, and the ingress VLAN and encapsulation. • For *session_number*, specify the session number entered in Step 4.

	Command or Action	Purpose

	`interface gigabitethernet1/0/2 encapsulation replicate ingress dot1q vlan 6`	• For *interface-id*, specify the destination port. The destination interface must be a physical port; it cannot be an EtherChannel, and it cannot be a VLAN.
		• (Optional) [**,** | -]—Specifies a series or range of interfaces. Enter a space before and after the comma or hyphen.
		• (Optional) **encapsulation replicate**—Specifies that the destination interface replicates the source interface encapsulation method. If not selected, the default is to send packets in native form (untagged).
		• **ingress**—Enables forwarding of incoming traffic on the destination port and to specify the encapsulation type.
		  • **dot1q vlan** *vlan-id*—Accepts incoming packets with IEEE 802.1Q encapsulation with the specified VLAN as the default VLAN.
		  • **untagged vlan** *vlan-id* or **vlan** *vlan-id*—Accepts incoming packets with untagged encapsulation type with the specified VLAN as the default VLAN.

Step 6	**end** **Example:** `Device(config)# end`	Returns to privileged EXEC mode.
Step 7	**show running-config** **Example:** `Device# show running-config`	Verifies your entries.
Step 8	**copy running-config startup-config** **Example:** `Device# copy running-config startup-config`	(Optional) Saves your entries in the configuration file.

Specifying VLANs to Filter

Follow these steps to limit SPAN source traffic to specific VLANs.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **no monitor session** {*session_number* | **all** | **local** | **remote**}
4. **monitor session** *session_number* **source interface** *interface-id*
5. **monitor session** *session_number* **filter vlan** *vlan-id* [**,** | **-**]
6. **monitor session** *session_number* **destination** {**interface** *interface-id* [**,** | **-**] [**encapsulation replicate**]}
7. **end**
8. **show running-config**
9. **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**no monitor session** {*session_number* | **all** | **local** | **remote**} **Example:** `Device(config)# no monitor session all`	Removes any existing SPAN configuration for the session. • For *session_number*, the range is 1 to 66. • **all**—Removes all SPAN sessions. • **local**—Removes all local sessions. • **remote**—Removes all remote SPAN sessions.
Step 4	**monitor session** *session_number* **source interface** *interface-id* **Example:** `Device(config)# monitor session 2 source interface gigabitethernet1/0/2 rx`	Specifies the characteristics of the source port (monitored port) and SPAN session. • For *session_number*, the range is 1 to 66. • For *interface-id*, specify the source port to monitor. The interface specified must already be configured as a trunk port.
Step 5	**monitor session** *session_number* **filter vlan** *vlan-id* [**,**	**-**] **Example:** `Device(config)# monitor session 2 filter vlan 1 - 5 , 9`	Limits the SPAN source traffic to specific VLANs. • For *session_number*, enter the session number specified in Step 4. • For *vlan-id*, the range is 1 to 4094.

	Command or Action	Purpose
		• (Optional) Use a comma (**,**) to specify a series of VLANs, or use a hyphen (**-**) to specify a range of VLANs. Enter a space before and after the comma; enter a space before and after the hyphen.
Step 6	**monitor session** *session_number* **destination** {**interface** *interface-id* [**,** | **-**] [**encapsulation replicate]**} **Example:** `Device(config)# monitor session 2 destination interface gigabitethernet1/0/1`	Specifies the SPAN session and the destination port (monitoring port). • For *session_number*, specify the session number entered in Step 4. • For *interface-id*, specify the destination port. The destination interface must be a physical port; it cannot be an EtherChannel, and it cannot be a VLAN. • (Optional) [**,** | **-**] Specifies a series or range of interfaces. Enter a space before and after the comma; enter a space before and after the hyphen. • (Optional) **encapsulation replicate** specifies that the destination interface replicates the source interface encapsulation method. If not selected, the default is to send packets in native form (untagged).
Step 7	**end** **Example:** `Device(config)# end`	Returns to privileged EXEC mode.
Step 8	**show running-config** **Example:** `Device# show running-config`	Verifies your entries.
Step 9	**copy running-config startup-config** **Example:** `Device# copy running-config startup-config`	(Optional) Saves your entries in the configuration file.

Configuring a VLAN as an RSPAN VLAN

Follow these steps to create a new VLAN, then configure it to be the RSPAN VLAN for the RSPAN session.

SUMMARY STEPS

1. **enable**

2. **configure terminal**
3. **vlan** *vlan-id*
4. **remote-span**
5. **end**
6. **show running-config**
7. **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**vlan** *vlan-id* **Example:** `Device(config)# vlan 100`	Enters a VLAN ID to create a VLAN, or enters the VLAN ID of an existing VLAN, and enters VLAN configuration mode. The range is 2 to 1001 and 1006 to 4094. The RSPAN VLAN cannot be VLAN 1 (the default VLAN) or VLAN IDs 1002 through 1005 (reserved for Token Ring and FDDI VLANs).
Step 4	**remote-span** **Example:** `Device(config-vlan)# remote-span`	Configures the VLAN as an RSPAN VLAN.
Step 5	**end** **Example:** `Device(config-vlan)# end`	Returns to privileged EXEC mode.
Step 6	**show running-config** **Example:** `Device# show running-config`	Verifies your entries.
Step 7	**copy running-config startup-config** **Example:**	(Optional) Saves your entries in the configuration file.

	Command or Action	Purpose
	`Device# copy running-config startup-config`	

What to do next

You must create the RSPAN VLAN in all devices that will participate in RSPAN. If the RSPAN VLAN-ID is in the normal range (lower than 1005) and VTP is enabled in the network, you can create the RSPAN VLAN in one device, and VTP propagates it to the other devices in the VTP domain. For extended-range VLANs (greater than 1005), you must configure RSPAN VLAN on both source and destination devices and any intermediate devices.

Use VTP pruning to get an efficient flow of RSPAN traffic, or manually delete the RSPAN VLAN from all trunks that do not need to carry the RSPAN traffic.

To remove the remote SPAN characteristic from a VLAN and convert it back to a normal VLAN, use the **no remote-span** VLAN configuration command.

To remove a source port or VLAN from the SPAN session, use the **no monitor session** *session_number* **source** {**interface** *interface-id* | **vlan** *vlan-id*} global configuration command. To remove the RSPAN VLAN from the session, use the **no monitor session** *session_number* **destination remote vlan** *vlan-id*.

Creating an RSPAN Source Session

Follow these steps to create and start an RSPAN source session and to specify the monitored source and the destination RSPAN VLAN.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **no monitor session** {*session_number* | **all** | **local** | **remote**}
4. **monitor session** *session_number* **source** {**interface** *interface-id* | **vlan** *vlan-id*} [**,** | **-**] [**both** | **rx** | **tx**]
5. **monitor session** *session_number* **destination remote vlan** *vlan-id*
6. **end**
7. **show running-config**
8. **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:**	Enters global configuration mode.

	Command or Action	Purpose
	`Device# configure terminal`	
Step 3	**no monitor session** {*session_number* | **all** | **local** | **remote**} **Example:** `Device(config)# no monitor session 1`	Removes any existing SPAN configuration for the session. • For *session_number*, the range is 1 to 66. • **all**—Removes all SPAN sessions. • **local**—Removes all local sessions. • **remote**—Removes all remote SPAN sessions.

Step 4	**monitor session** *session_number* **source** {**interface** *interface-id* | **vlan** *vlan-id*} [**,** | **-**] [**both** | **rx** | **tx**]
	Example:
	`Device(config)# monitor session 1 source interface gigabitethernet1/0/1 tx`
		Specifies the RSPAN session and the source port (monitored port).
		• For *session_number*, the range is 1 to 66.
		• Enter a source port or source VLAN for the RSPAN session:
		  • For *interface-id*, specifies the source port to monitor. Valid interfaces include physical interfaces and port-channel logical interfaces (**port-channel** *port-channel-number*). Valid port-channel numbers are 1 to 48.
		  • For *vlan-id*, specifies the source VLAN to monitor. The range is 1 to 4094 (excluding the RSPAN VLAN).
		  A single session can include multiple sources (ports or VLANs), defined in a series of commands, but you cannot combine source ports and source VLANs in one session.
		• (Optional) [**,** | **-**]—Specifies a series or range of interfaces. Enter a space before and after the comma; enter a space before and after the hyphen.
		• (Optional) **both** | **rx** | **tx**—Specifies the direction of traffic to monitor. If you do not specify a traffic direction, the source interface sends both sent and received traffic.
		  • **both**—Monitors both received and sent traffic.
		  • **rx**—Monitors received traffic.
		  • **tx**—Monitors sent traffic.

Step 5	**monitor session** *session_number* **destination remote vlan** *vlan-id*	Specifies the RSPAN session, the destination RSPAN VLAN, and the destination-port group.

	Command or Action	Purpose
	Example: `Device(config)# monitor session 1 destination remote vlan 100`	• For *session_number*, enter the number defined in Step 4. • For *vlan-id*, specify the source RSPAN VLAN to monitor.
Step 6	**end** **Example:** `Device(config)# end`	Returns to privileged EXEC mode.
Step 7	**show running-config** **Example:** `Device# show running-config`	Verifies your entries.
Step 8	**copy running-config startup-config** **Example:** `Device# copy running-config startup-config`	(Optional) Saves your entries in the configuration file.

Specifying VLANs to Filter

Follow these steps to configure the RSPAN source session to limit RSPAN source traffic to specific VLANs.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **no monitor session** {*session_number* | **all** | **local** | **remote**}
4. **monitor session** *session_number* **source interface** *interface-id*
5. **monitor session** *session_number* **filter vlan** *vlan-id* [**,** | **-**]
6. **monitor session** *session_number* **destination remote vlan** *vlan-id*
7. **end**
8. **show running-config**
9. **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:**	Enables privileged EXEC mode. • Enter your password if prompted.

	Command or Action	Purpose
	`Device> enable`	
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**no monitor session** {*session_number* | **all** | **local** | **remote**} **Example:** `Device(config)# no monitor session 2`	Removes any existing SPAN configuration for the session. • For *session_number*, the range is 1 to 66. • **all**—Removes all SPAN sessions. • **local**—Removes all local sessions. • **remote**—Removes all remote SPAN sessions.
Step 4	**monitor session** *session_number* **source interface** *interface-id* **Example:** `Device(config)# monitor session 2 source interface gigabitethernet1/0/2 rx`	Specifies the characteristics of the source port (monitored port) and SPAN session. • For *session_number*, the range is 1 to 66. • For *interface-id*, specify the source port to monitor. The interface specified must already be configured as a trunk port.
Step 5	**monitor session** *session_number* **filter vlan** *vlan-id* [**,** | **-**] **Example:** `Device(config)# monitor session 2 filter vlan 1 - 5 , 9`	Limits the SPAN source traffic to specific VLANs. • For *session_number*, enter the session number specified in step 4. • For *vlan-id*, the range is 1 to 4094. • (Optional) **,** | **-** Use a comma (**,**) to specify a series of VLANs or use a hyphen (**-**) to specify a range of VLANs. Enter a space before and after the comma; enter a space before and after the hyphen.
Step 6	**monitor session** *session_number* **destination remote vlan** *vlan-id* **Example:** `Device(config)# monitor session 2 destination remote vlan 902`	Specifies the RSPAN session and the destination remote VLAN (RSPAN VLAN). • For *session_number*, enter the session number specified in Step 4. • For *vlan-id*, specify the RSPAN VLAN to carry the monitored traffic to the destination port.
Step 7	**end** **Example:**	Returns to privileged EXEC mode.

	Command or Action	Purpose
	`Device(config)# end`	
Step 8	**show running-config** **Example:** `Device# show running-config`	Verifies your entries.
Step 9	**copy running-config startup-config** **Example:** `Device# copy running-config startup-config`	(Optional) Saves your entries in the configuration file.

Creating an RSPAN Destination Session

You configure an RSPAN destination session on a different device or device stack; that is, not the device or device stack on which the source session was configured.

Follow these steps to define the RSPAN VLAN on that device, to create an RSPAN destination session, and to specify the source RSPAN VLAN and the destination port.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **vlan** *vlan-id*
4. **remote-span**
5. **exit**
6. **no monitor session** {*session_number* | **all** | **local** | **remote**}
7. **monitor session** *session_number* **source remote vlan** *vlan-id*
8. **monitor session** *session_number* **destination interface** *interface-id*
9. **end**
10. **show running-config**
11. **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.

	Command or Action	Purpose
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**vlan** *vlan-id* **Example:** `Device(config)# vlan 901`	Specifies the VLAN ID of the RSPAN VLAN created from the source device, and enters VLAN configuration mode. If both devices are participating in VTP and the RSPAN VLAN ID is from 2 to 1005, Steps 3 through 5 are not required because the RSPAN VLAN ID is propagated through the VTP network.
Step 4	**remote-span** **Example:** `Device(config-vlan)# remote-span`	Identifies the VLAN as the RSPAN VLAN.
Step 5	**exit** **Example:** `Device(config-vlan)# exit`	Returns to global configuration mode.
Step 6	**no monitor session** {*session_number* | **all** | **local** | **remote**} **Example:** `Device(config)# no monitor session 1`	Removes any existing SPAN configuration for the session. • For *session_number*, the range is 1 to 66. • **all**—Removes all SPAN sessions. • **local**—Removes all local sessions. • **remote**—Removes all remote SPAN sessions.
Step 7	**monitor session** *session_number* **source remote vlan** *vlan-id* **Example:** `Device(config)# monitor session 1 source remote vlan 901`	Specifies the RSPAN session and the source RSPAN VLAN. • For *session_number*, the range is 1 to 66. • For *vlan-id*, specify the source RSPAN VLAN to monitor.
Step 8	**monitor session** *session_number* **destination interface** *interface-id* **Example:** `Device(config)# monitor session 1 destination interface gigabitethernet2/0/1`	Specifies the RSPAN session and the destination interface. • For *session_number*, enter the number defined in Step 7. In an RSPAN destination session, you must use the same session number for the source RSPAN VLAN and the destination port.

	Command or Action	Purpose
		• For *interface-id*, specify the destination interface. The destination interface must be a physical interface. • Though visible in the command-line help string, **encapsulation replicate** is not supported for RSPAN. The original VLAN ID is overwritten by the RSPAN VLAN ID, and all packets appear on the destination port as untagged.
Step 9	**end** **Example:** `Device(config)# end`	Returns to privileged EXEC mode.
Step 10	**show running-config** **Example:** `Device# show running-config`	Verifies your entries.
Step 11	**copy running-config startup-config** **Example:** `Device# copy running-config startup-config`	(Optional) Saves your entries in the configuration file.

Creating an RSPAN Destination Session and Configuring Incoming Traffic

Follow these steps to create an RSPAN destination session, to specify the source RSPAN VLAN and the destination port, and to enable incoming traffic on the destination port for a network security device (such as a Cisco IDS Sensor Appliance).

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **no monitor session** {*session_number* | **all** | **local** | **remote**}
4. **monitor session** *session_number* **source remote vlan** *vlan-id*
5. **monitor session** *session_number* **destination** {**interface** *interface-id* [**,** | **-**] [**ingress** {**dot1q vlan** *vlan-id* | **untagged vlan** *vlan-id* **| vlan** *vlan-id*}]}
6. **end**
7. **show running-config**
8. **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**no monitor session** {*session_number* | **all** | **local** | **remote**} **Example:** `Device(config)# no monitor session 2`	Removes any existing SPAN configuration for the session. • For *session_number*, the range is 1 to 66. • **all**—Removes all SPAN sessions. • **local**—Removes all local sessions. • **remote**—Removes all remote SPAN sessions.
Step 4	**monitor session** *session_number* **source remote vlan** *vlan-id* **Example:** `Device(config)# monitor session 2 source remote vlan 901`	Specifies the RSPAN session and the source RSPAN VLAN. • For *session_number*, the range is 1 to 66. • For *vlan-id*, specify the source RSPAN VLAN to monitor.
Step 5	**monitor session** *session_number* **destination** {**interface** *interface-id* [**,** | -] [**ingress** {**dot1q vlan** *vlan-id* | **untagged vlan** *vlan-id* | **vlan** *vlan-id*}]} **Example:** `Device(config)# monitor session 2 destination interface gigabitethernet1/0/2 ingress vlan 6`	Specifies the SPAN session, the destination port, the packet encapsulation, and the incoming VLAN and encapsulation. • For *session_number*, enter the number defined in Step 5. In an RSPAN destination session, you must use the same session number for the source RSPAN VLAN and the destination port. • For *interface-id*, specify the destination interface. The destination interface must be a physical interface. • Though visible in the command-line help string, **encapsulation replicate** is not supported for RSPAN. The original VLAN ID is overwritten by the RSPAN VLAN ID, and all packets appear on the destination port as untagged. • (Optional) [**,** | -] Specifies a series or range of interfaces. Enter a space before and after the comma; enter a space before and after the hyphen.

	Command or Action	Purpose
		• Enter **ingress** with additional keywords to enable forwarding of incoming traffic on the destination port and to specify the encapsulation type: • **dot1q vlan** *vlan-id*—Forwards incoming packets with IEEE 802.1Q encapsulation with the specified VLAN as the default VLAN. • **untagged vlan** *vlan-id* or **vlan** *vlan-id*—Forwards incoming packets with untagged encapsulation type with the specified VLAN as the default VLAN.
Step 6	**end** **Example:** `Device(config)# end`	Returns to privileged EXEC mode.
Step 7	**show running-config** **Example:** `Device# show running-config`	Verifies your entries.
Step 8	**copy running-config startup-config** **Example:** `Device# copy running-config startup-config`	(Optional) Saves your entries in the configuration file.

Configuring an FSPAN Session

Follow these steps to create a SPAN session, specify the source (monitored) ports or VLANs and the destination (monitoring) ports, and configure FSPAN for the session.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **no monitor session** {*session_number* | **all** | **local** | **remote**}
4. **monitor session** *session_number* **source** {**interface** *interface-id* | **vlan** *vlan-id*} [**,** | **-**] [**both** | **rx** | **tx**]
5. **monitor session** *session_number* **destination** {**interface** *interface-id* [**,** | **-**] [**encapsulation replicate**]}
6. **monitor session** *session_number* **filter** {**ip** | **ipv6** | **mac**} **access-group** {*access-list-number* | *name*}
7. **end**
8. **show running-config**
9. **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**no monitor session** {*session_number* | **all** | **local** | **remote**} **Example:** `Device(config)# no monitor session 2`	Removes any existing SPAN configuration for the session. • For *session_number*, the range is 1 to 66. • **all**—Removes all SPAN sessions. • **local**—Removes all local sessions. • **remote**—Removes all remote SPAN sessions.
Step 4	**monitor session** *session_number* **source** {**interface** *interface-id* | **vlan** *vlan-id*} [**,** | **-**] [**both** | **rx** | **tx**] **Example:** `Device(config)# monitor session 2 source interface gigabitethernet1/0/1`	Specifies the SPAN session and the source port (monitored port). • For *session_number*, the range is 1 to 66. • For *interface-id*, specifies the source port to monitor. Valid interfaces include physical interfaces and port-channel logical interfaces (**port-channel** *port-channel-number*). Valid port-channel numbers are 1 to 48. • For *vlan-id*, specify the source VLAN to monitor. The range is 1 to 4094 (excluding the RSPAN VLAN). **Note** A single session can include multiple sources (ports or VLANs) defined in a series of commands, but you cannot combine source ports and source VLANs in one session. • (Optional) [**,** | **-**]—Specifies a series or range of interfaces. Enter a space before and after the comma; enter a space before and after the hyphen. • (Optional) [**both** | **rx** | **tx**]—Specifies the direction of traffic to monitor. If you do not specify a traffic direction, the SPAN monitors both sent and received traffic.

	Command or Action	Purpose
		• **both**—Monitors both sent and received traffic. This is the default. • **rx**—Monitors received traffic. • **tx**—Monitors sent traffic. **Note** You can use the **monitor session** *session_number* **source** command multiple times to configure multiple source ports.
Step 5	**monitor session** *session_number* **destination** {**interface** *interface-id* [**,** | **-**] [**encapsulation replicate**]} **Example:** `Device(config)# monitor session 2 destination interface gigabitethernet1/0/2 encapsulation replicate`	Specifies the SPAN session and the destination port (monitoring port). • For *session_number*, specify the session number entered in Step 4. • For **destination**, specify the following parameters: • For *interface-id*, specify the destination port. The destination interface must be a physical port; it cannot be an EtherChannel, and it cannot be a VLAN. • (Optional) [**,** | **-**] Specifies a series or range of interfaces. Enter a space before and after the comma; enter a space before and after the hyphen. • (Optional) **encapsulation replicate** specifies that the destination interface replicates the source interface encapsulation method. If not selected, the default is to send packets in native form (untagged). **Note** For local SPAN, you must use the same session number for the source and destination interfaces. You can use **monitor session** *session_number* **destination** command multiple times to configure multiple destination ports.
Step 6	**monitor session** *session_number* **filter** {**ip** | **ipv6** | **mac**} **access-group** {*access-list-number* | *name*} **Example:** `Device(config)# monitor session 2 filter ipv6 access-group 4`	Specifies the SPAN session, the types of packets to filter, and the ACLs to use in an FSPAN session. • For *session_number*, specify the session number entered in Step 4. • For *access-list-number*, specify the ACL number that you want to use to filter traffic. • For *name*, specify the ACL name that you want to use to filter traffic.

	Command or Action	Purpose
Step 7	**end** **Example:** `Device(config)# end`	Returns to privileged EXEC mode.
Step 8	**show running-config** **Example:** `Device# show running-config`	Verifies your entries.
Step 9	**copy running-config startup-config** **Example:** `Device# copy running-config startup-config`	(Optional) Saves your entries in the configuration file.

Configuring an FRSPAN Session

Follow these steps to start an RSPAN source session, specify the monitored source and the destination RSPAN VLAN, and configure FRSPAN for the session.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **no monitor session** {*session_number* | **all** | **local** | **remote**}
4. **monitor session** *session_number* **source** {**interface** *interface-id* | **vlan** *vlan-id*} [**,** | **-**] [**both** | **rx** | **tx**]
5. **monitor session** *session_number* **destination remote vlan** *vlan-id*
6. **vlan** *vlan-id*
7. **remote-span**
8. **exit**
9. **monitor session** *session_number* **filter** {**ip** | **ipv6** | **mac**} **access-group** {*access-list-number* | *name*}
10. **end**
11. **show running-config**
12. **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.

	Command or Action	Purpose
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**no monitor session** {*session_number* | **all** | **local** | **remote**} **Example:** `Device(config)# no monitor session 2`	Removes any existing SPAN configuration for the session. • For *session_number*, the range is 1 to 66. • **all**—Removes all SPAN sessions. • **local**—Removes all local sessions. • **remote**—Removes all remote SPAN sessions.
Step 4	**monitor session** *session_number* **source** {**interface** *interface-id* | **vlan** *vlan-id*} [**,** | **-**] [**both** | **rx** | **tx**] **Example:** `Device(config)# monitor session 2 source interface gigabitethernet1/0/1`	Specifies the SPAN session and the source port (monitored port). • For *session_number*, the range is 1 to 66. • For *interface-id*, specifies the source port to monitor. Valid interfaces include physical interfaces and port-channel logical interfaces (**port-channel** *port-channel-number*). Valid port-channel numbers are 1 to 48. • For *vlan-id*, specify the source VLAN to monitor. The range is 1 to 4094 (excluding the RSPAN VLAN). **Note** A single session can include multiple sources (ports or VLANs) defined in a series of commands, but you cannot combine source ports and source VLANs in one session. • (Optional) [**,** | **-**]—Specifies a series or range of interfaces. Enter a space before and after the comma; enter a space before and after the hyphen. • (Optional) [**both** | **rx** | **tx**]—Specifies the direction of traffic to monitor. If you do not specify a traffic direction, the SPAN monitors both sent and received traffic. • **both**—Monitors both sent and received traffic. This is the default. • **rx**—Monitors received traffic. • **tx**—Monitors sent traffic.

	Command or Action	Purpose
		Note You can use the **monitor session** *session_number* **source** command multiple times to configure multiple source ports.
Step 5	**monitor session** *session_number* **destination remote vlan** *vlan-id* **Example:** `Device(config)# monitor session 2 destination remote vlan 5`	Specifies the RSPAN session and the destination RSPAN VLAN. • For *session_number*, enter the number defined in Step 4. • For *vlan-id*, specify the destination RSPAN VLAN to monitor.
Step 6	**vlan** *vlan-id* **Example:** `Device(config)# vlan 10`	Enters the VLAN configuration mode. For *vlan-id*, specify the source RSPAN VLAN to monitor.
Step 7	**remote-span** **Example:** `Device(config-vlan)# remote-span`	Specifies that the VLAN you specified in Step 5 is part of the RSPAN VLAN.
Step 8	**exit** **Example:** `Device(config-vlan)# exit`	Returns to global configuration mode.
Step 9	**monitor session** *session_number* **filter** {**ip** | **ipv6** | **mac**} **access-group** {*access-list-number* | *name*} **Example:** `Device(config)# monitor session 2 filter ip access-group 7`	Specifies the RSPAN session, the types of packets to filter, and the ACLs to use in an FRSPAN session. • For *session_number*, specify the session number entered in Step 4. • For *access-list-number*, specify the ACL number that you want to use to filter traffic. • For *name*, specify the ACL name that you want to use to filter traffic.
Step 10	**end** **Example:** `Device(config)# end`	Returns to privileged EXEC mode.
Step 11	**show running-config** **Example:**	Verifies your entries.

	Command or Action	Purpose
	`Device# show running-config`	
Step 12	**copy running-config startup-config** **Example:** `Device# copy running-config startup-config`	(Optional) Saves your entries in the configuration file.

Monitoring SPAN and RSPAN Operations

The following table describes the command used to display SPAN and RSPAN operations configuration and results to monitor operations:

Table 9: Monitoring SPAN and RSPAN Operations

Command	Purpose
show monitor	Displays the current SPAN, RSPAN, FSPAN, or FRSPAN configuration.

SPAN and RSPAN Configuration Examples

Example: Configuring Local SPAN

This example shows how to set up SPAN session 1 for monitoring source port traffic to a destination port. First, any existing SPAN configuration for session 1 is deleted, and then bidirectional traffic is mirrored from source Gigabit Ethernet port 1 to destination Gigabit Ethernet port 2, retaining the encapsulation method.

```
Device> enable
Device# configure terminal
Device(config)# no monitor session 1
Device(config)# monitor session 1 source interface gigabitethernet1/0/1
Device(config)# monitor session 1 destination interface gigabitethernet1/0/2
encapsulation replicate
Device(config)# end
```

This example shows how to remove port 1 as a SPAN source for SPAN session 1:

```
Device> enable
Device# configure terminal
Device(config)# no monitor session 1 source interface gigabitethernet1/0/1
Device(config)# end
```

This example shows how to disable received traffic monitoring on port 1, which was configured for bidirectional monitoring:

```
Device> enable
Device# configure terminal
Device(config)# no monitor session 1 source interface gigabitethernet1/0/1 rx
```

The monitoring of traffic received on port 1 is disabled, but traffic sent from this port continues to be monitored.

This example shows how to remove any existing configuration on SPAN session 2, configure SPAN session 2 to monitor received traffic on all ports belonging to VLANs 1 through 3, and send it to destination Gigabit Ethernet port 2. The configuration is then modified to also monitor all traffic on all ports belonging to VLAN 10.

```
Device> enable
Device# configure terminal
Device(config)# no monitor session 2
Device(config)# monitor session 2 source vlan 1 - 3 rx
Device(config)# monitor session 2 destination interface gigabitethernet1/0/2
Device(config)# monitor session 2 source vlan 10
Device(config)# end
```

This example shows how to remove any existing configuration on SPAN session 2, configure SPAN session 2 to monitor received traffic on Gigabit Ethernet source port 1, and send it to destination Gigabit Ethernet port 2 with the same egress encapsulation type as the source port, and to enable ingress forwarding with VLAN 6 as the default ingress VLAN:

```
Device> enable
Device# configure terminal
Device(config)# no monitor session 2
Device(config)# monitor session 2 source gigabitethernet0/1 rx
Device(config)# monitor session 2 destination interface gigabitethernet0/2 encapsulation
replicate ingress vlan 6
Device(config)# end
```

This example shows how to remove any existing configuration on SPAN session 2, configure SPAN session 2 to monitor traffic received on Gigabit Ethernet trunk port 2, and send traffic for only VLANs 1 through 5 and VLAN 9 to destination Gigabit Ethernet port 1:

```
Device> enable
Device# configure terminal
Device(config)# no monitor session 2
Device(config)# monitor session 2 source interface gigabitethernet1/0/2 rx
Device(config)# monitor session 2 filter vlan 1 - 5 , 9
Device(config)# monitor session 2 destination interface gigabitethernet1/0/1
Device(config)# end
```

Examples: Creating an RSPAN VLAN

This example shows how to create the RSPAN VLAN 901:

```
Device> enable
Device# configure terminal
Device(config)# vlan 901
Device(config-vlan)# remote span
Device(config-vlan)# end
```

This example shows how to remove any existing RSPAN configuration for session 1, configure RSPAN session 1 to monitor multiple source interfaces, and configure the destination as RSPAN VLAN 901:

```
Device> enable
Device# configure terminal
Device(config)# no monitor session 1
Device(config)# monitor session 1 source interface gigabitethernet1/0/1 tx
Device(config)# monitor session 1 source interface gigabitethernet1/0/2 rx
Device(config)# monitor session 1 source interface port-channel 2
Device(config)# monitor session 1 destination remote vlan 901
Device(config)# end
```

This example shows how to remove any existing configuration on RSPAN session 2, configure RSPAN session 2 to monitor traffic received on trunk port 2, and send traffic for only VLANs 1 through 5 and 9 to destination RSPAN VLAN 902:

```
Device> enable
Device# configure terminal
Device(config)# no monitor session 2
Device(config)# monitor session 2 source interface gigabitethernet1/0/2 rx
Device(config)# monitor session 2 filter vlan 1 - 5 , 9
Device(config)# monitor session 2 destination remote vlan 902
Device(config)# end
```

This example shows how to configure VLAN 901 as the source remote VLAN and port 1 as the destination interface:

```
Device> enable
Device# configure terminal
Device(config)# monitor session 1 source remote vlan 901
Device(config)# monitor session 1 destination interface gigabitethernet2/0/1
Device(config)# end
```

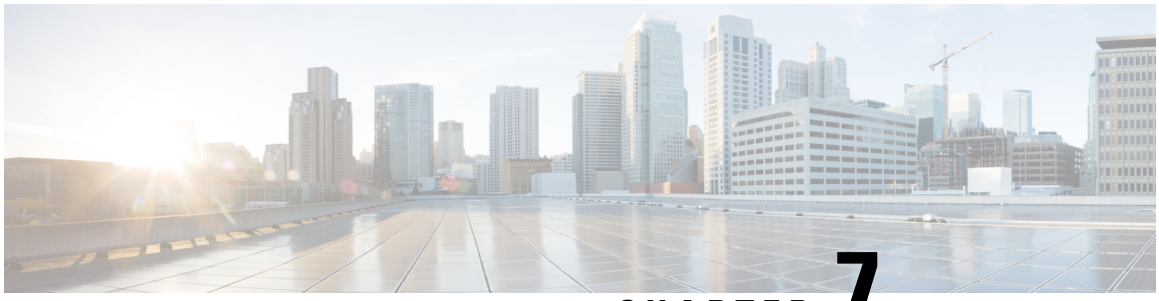
This example shows how to configure VLAN 901 as the source remote VLAN in RSPAN session 2, to configure Gigabit Ethernet source port 2 as the destination interface, and to enable forwarding of incoming traffic on the interface with VLAN 6 as the default receiving VLAN:

```
Device> enable
Device# configure terminal
Device(config)# monitor session 2 source remote vlan 901
Device(config)# monitor session 2 destination interface gigabitethernet1/0/2 ingress vlan 6
Device(config)# end
```

Feature History and Information for SPAN and RSPAN

Release	Modification
Cisco IOS XE Fuji 16.9.2	Switch Port Analyzer (SPAN): Allows monitoring of device traffic on a port or VLAN using a sniffer/analyzer or RMON probe. This feature was introduced.

Release	Modification
Cisco IOS XE Fuji 16.9.2	Flow-based Switch Port Analyzer (SPAN): Provides a method to capture only required data between end hosts by using specified filters. The filters are defined in terms of access lists that limit IPv4, IPv6 or IPv4 + IPv6, or non-IP traffic (MAC) between specified source and destination addresses. This feature was introduced.
Cisco IOS XE Fuji 16.9.2	Switch Port Analyzer (SPAN) - distributed egress SPAN: Provides distributed egress SPAN functionality onto line cards in conjunction with ingress SPAN already been distributed to line cards. By distributing egress SPAN functionalities onto line cards, the performance of the system is improved. This feature was introduced.



CHAPTER 7

Configuring Flexible NetFlow

Prerequisites for Flexible NetFlow

The following are prerequisites for your Flexible NetFlow configuration:

- You must configure a source interface. If you do not configure a source interface, the exporter remains in a disabled state.
- You must configure a valid record name for every flow monitor.
- You must enable IPv6 routing to export the flow records to an IPv6 destination server.
- You must configure IPFIX export protocol for the flow exporter to export netflow records in IPFIX format.
- You are familiar with the Flexible NetFlow key fields as they are defined in the following commands in the Cisco IOS Flexible NetFlow Command Reference:
  - **match datalink**—Datalink (layer2) fields
  - **match flow**—Flow identifying fields
  - **match interface**—Interface fields
  - **match ipv4**—IPv4 fields
  - **match ipv6**—IPv6 fields
  - **match transport**—Transport layer fields
  - **match flow cts**—CTS fields

- You are familiar with the Flexible NetFlow non-key fields as they are defined in the following commands in the Cisco IOS Flexible NetFlow Command Reference :
  - **collect counter**—Counter fields
  - **collect flow**—Flow identifying fields
  - **collect interface**—Interface fields
  - **collect timestamp**—Timestamp fields
  - **collect transport**—Transport layer fields

IPv4 Traffic

- The networking device must be configured for IPv4 routing.
- One of the following must be enabled on your device and on any interfaces on which you want to enable Flexible NetFlow: Cisco Express Forwarding or distributed Cisco Express Forwarding.

IPv6 Traffic

- The networking device must be configured for IPv6 routing.
- One of the following must be enabled on your device and on any interfaces on which you want to enable Flexible NetFlow: Cisco Express Forwarding IPv6 or distributed Cisco Express Forwarding.

Restrictions for Flexible NetFlow

The following are restrictions for Flexible NetFlow:

- Flexible NetFlow is not supported on the Layer 2 port-channel interface, but is supported on the Layer 2 port-channel member ports.
- Flexible NetFlow is supported on the Layer 3 port-channel interfaces and member ports but not on both at the same time for the same traffic type and direction.
- Traditional NetFlow accounting is not supported.
- Flexible NetFlow Version 9 and Version 10 export formats are supported. However, if you have not configured the export protocol, Version 9 export format is applied by default.
- For wired Application Visibility and Control (AVC) traffic, only one flow monitor can be configured on one or more Layer 2 or Layer 3 physical interfaces on the system.
- Flexible NetFlow and NBAR cannot be configured together at the same time on the same interface.
- Layer 2, IPv4, and IPv6 traffic types are supported. Multiple flow monitors of different traffic types can be applied for a given interface and direction. Multiple flow monitors of same traffic type cannot be applied for a given interface and direction.
- The device does not support tunnels and SVI interfaces; however Layer 2 and Layer 3 physical interfaces and VLAN configuration mode are supported.

- Depending on the switch type, a switch will have one or two forwarding ASICs. The capacities listed in the above table are on a per-Core/per-ASIC basis.
- The switch has a single core ASIC and the total flows supported is 16K flows (8K per ingress and egress directions). The TCAM limit is 128 entries per direction.
- The NetFlow tables are on separate compartments and cannot be combined. Depending on which core processed the packet, the flows will be created in the table in the corresponding core.
- NetFlow hardware implementation supports four hardware samplers. You can select a sampler rate from 1 out of 2 to 1 out of 1024. Both — random and deterministic — sampling modes are supported.
- NetFlow hardware uses hash tables internally. Hash collisions can occur in the hardware. Therefore, in spite of the internal overflow Content Addressable Memory (CAM), the actual NetFlow table utilization could be about 80 percent.
- Depending on the fields that are used for the flow, a single flow could take two consecutive entries. IPv6 and datalink flows also take two entries. In these situations, the effective usage of NetFlow entries is half the table size, which is separate from the above hash collision limitation.
- The device supports up to 15 flow monitors.
- The NetFlow software implementation supports distributed NetFlow export, so the flows are exported from the same device in which the flow was created.
- Ingress flows are present in the ASIC that first received the packets for the flow. Egress flows are present in the ASIC from which the packets actually left the device set up.
- The reported value for the bytes count field (called “bytes long”) is Layer-2-packet-size—18 bytes. For classic Ethernet traffic (802.3), this will be accurate. For all other Ethernet types, this field will not be accurate. Use the "bytes layer2” field, which always reports the accurate Layer 2 packet size. For information about supported Flexible NetFlow fields, see 'Supported Flexible NetFlow Fields' topic.
- Configuration of IPFIX exporter on an AVC flow monitor is not supported.
- Flexible NetFlow export is not supported on the Ethernet management port, GigabitEthernet 0/0.
- When a flow record has only Source Group Tag (SGT) and Destination Group Tag (DGT) fields (or only either of the two) and if both the values are not applicable, then a flow will still be created with zero values for SGT and DGT. The flow records are expected to include source and destination IP addresses, along with SGT and DGT fields.
- On non-Cisco TrustSec interfaces, an SGT value of zero implies that there is no command header. On Cisco TrustSec interfaces, an SGT value of zero implies an unknown tag.
- For an IPv6 flow monitor, Source Group Tag (SGT) and Destination Group Tag (DGT) fields cannot co-exist with MAC address fields.
- When a quality of service (QoS) marked packet is received on an interface which has NetFlow configured in the ingress direction, the QoS value of the packet is captured by the NetFlow collector. However, when the packet is received on an interface which has NetFlow configured in the egress direction and the QoS value has been rewritten on ingress by the switch, the new QoS value of the packet is not captured by the collector.
- NetFlow records do not support MultiProtocol Label Switching-enabled (MPLS-enabled) interfaces.

- A flow monitor cannot be shared across Layer 3 physical interfaces and logical interfaces (such as, Layer 3 port-channel interface, Layer 3 port-channel member, and switch virtual interface [SVI]), but a flow monitor can be shared across logical interfaces or Layer 3 physical interfaces.

Information About Flexible Netflow

Flexible NetFlow Overview

Flexible NetFlow uses flows to provide statistics for accounting, network monitoring, and network planning.

A flow is a unidirectional stream of packets that arrives on a source interface and has the same values for the keys. A key is an identified value for a field within the packet. You create a flow using a flow record to define the unique keys for your flow.

The device supports the Flexible NetFlow feature that enables enhanced network anomalies and security detection. Flexible NetFlow allows you to define an optimal flow record for a particular application by selecting the keys from a large collection of predefined fields.

All key values must match for the packet to count in a given flow. A flow might gather other fields of interest, depending on the export record version that you configure. Flows are stored in the Flexible NetFlow cache.

You can export the data that Flexible NetFlow gathers for your flow by using an exporter and export this data to a remote system such as a Flexible NetFlow collector. The Flexible NetFlow collector can use an IPv4 address.

You define the size of the data that you want to collect for a flow using a monitor. The monitor combines the flow record and exporter with the Flexible NetFlow cache information.

Original NetFlow and Benefits of Flexible NetFlow

Flexible NetFlow allows the flow to be user defined. The benefits of Flexible NetFlow include:

- High-capacity flow recognition, including scalability and aggregation of flow information.
- Enhanced flow infrastructure for security monitoring and dDoS detection and identification.
- New information from packets to adapt flow information to a particular service or operation in the network. The flow information available will be customizable by Flexible NetFlow users.
- Extensive use of Cisco’s flexible and extensible NetFlow Version 9.
- A comprehensive IP accounting feature that can be used to replace many accounting features, such as IP accounting, Border Gateway Protocol (BGP) Policy Accounting, and persistent caches.

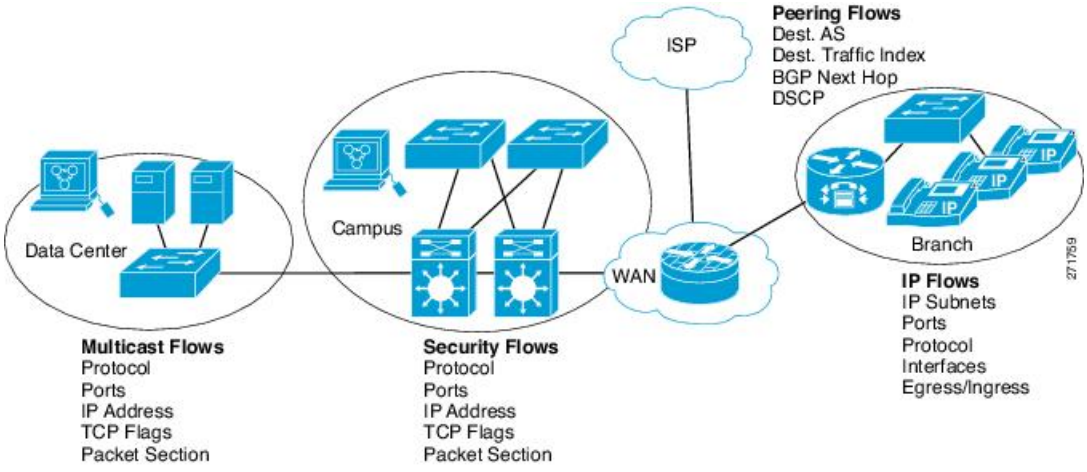
Flexible NetFlow allows you to understand network behavior with more efficiency, with specific flow information tailored for various services used in the network. The following are some example applications for a Flexible NetFlow feature:

- Flexible NetFlow enhances Cisco NetFlow as a security monitoring tool. For instance, new flow keys can be defined for packet length or MAC address, allowing users to search for a specific type of attack in the network.

- Flexible NetFlow allows you to quickly identify how much application traffic is being sent between hosts by specifically tracking TCP or UDP applications by the class of service (CoS) in the packets.
- The accounting of traffic entering a Multiprotocol Label Switching (MPLS) or IP core network and its destination for each next hop per class of service. This capability allows the building of an edge-to-edge traffic matrix.

The figure below is an example of how Flexible NetFlow might be deployed in a network.

Figure 8: Typical Deployment for Flexible NetFlow



Flexible NetFlow Components

Flexible NetFlow consists of components that can be used together in several variations to perform traffic analysis and data export. The user-defined flow records and the component structure of Flexible NetFlow facilitates the creation of various configurations for traffic analysis and data export on a networking device with a minimum number of configuration commands. Each flow monitor can have a unique combination of flow record, flow exporter, and cache type. If you change a parameter such as the destination IP address for a flow exporter, it is automatically changed for all the flow monitors that use the flow exporter. The same flow monitor can be used in conjunction with different flow samplers to sample the same type of network traffic at different rates on different interfaces. The following sections provide more information on Flexible NetFlow components:

Flow Records

In Flexible NetFlow a combination of key and nonkey fields is called a record. Flexible NetFlow records are assigned to Flexible NetFlow flow monitors to define the cache that is used for storing flow data. Flexible NetFlow includes several predefined records that can help you get started using Flexible NetFlow.

A flow record defines the keys that Flexible NetFlow uses to identify packets in the flow, as well as other fields of interest that Flexible NetFlow gathers for the flow. You can define a flow record with any combination of keys and fields of interest. The device supports a rich set of keys. A flow record also defines the types of counters gathered per flow. You can configure 64-bit packet or byte counters. The device enables the following match fields as the defaults when you create a flow record:

- **match datalink**—Layer 2 attributes

- **match flow direction**—Specifies a match to the fields identifying the direction of flow.
- **match interface**—Interface attributes
- **match ipv4**—IPv4 attributes
- **match ipv6**—IPv6 attributes
- **match transport**—Transport layer fields
- **match flow cts**—Cisco TrustSec fields

NetFlow Predefined Records

Flexible NetFlow includes several predefined records that you can use to start monitoring traffic in your network. The predefined records are available to help you quickly deploy Flexible NetFlow and are easier to use than user-defined flow records. You can choose from a list of already defined records that may meet the needs for network monitoring. As Flexible NetFlow evolves, popular user-defined flow records will be made available as predefined records to make them easier to implement.

Note Predefined records are not supported for regular Flexible NetFlow on Cisco Catalyst 9000 Series Switches.

User-Defined Records

Flexible NetFlow enables you to define your own records for a Flexible NetFlow flow monitor cache by specifying the key and nonkey fields to customize the data collection to your specific requirements. When you define your own records for a Flexible NetFlow flow monitor cache, they are referred to as *user-defined records*. The values in nonkey fields are added to flows to provide additional information about the traffic in the flows. A change in the value of a nonkey field does not create a new flow. In most cases the values for nonkey fields are taken from only the first packet in the flow. Flexible NetFlow enables you to capture counter values such as the number of bytes and packets in a flow as nonkey fields.

Flexible NetFlow adds a new Version 9 export format field type for the header and packet section types. Flexible NetFlow will communicate to the NetFlow collector the configured section sizes in the corresponding Version 9 export template fields. The payload sections will have a corresponding length field that can be used to collect the actual size of the collected section.

Flexible NetFlow Match Parameters

The following table describes Flexible NetFlow match parameters. You must configure at least one of the following match parameters for the flow records.

Table 10: Match Parameters

Command	Purpose
match datalink {**dot1q** | **ethertype** | **mac** | **vlan** }	Specifies a match to datalink or Layer 2 fields. The following command options are available: • **dot1q**—Matches to the dot1q field. • **ethertype**—Matches to the ethertype of the packet. • **mac**—Matches the source or destination MAC fields. • **vlan**—Matches to the VLAN that the packet is located on (input or output).
match flow direction	Specifies a match to the flow identifying fields.
match interface {**input** | **output**}	Specifies a match to the interface fields. The following command options are available: • **input**—Matches to the input interface. • **output**—Matches to the output interface.
match ipv4 {**destination** | **protocol** | **source** | **tos** | **ttl** | **version**}	Specifies a match to the IPv4 fields. The following command options are available: • **destination**—Matches to the IPv4 destination address-based fields. • **protocol**—Matches to the IPv4 protocols. • **source**—Matches to the IPv4 source address based fields. • **tos**—Matches to the IPv4 Type of Service fields. • **ttl**—Matches to the IPv4 Time To Live fields. • **version**—Matches to the IP version from the IPv4 header.

Command	Purpose
match ipv6 {**destination** | **hop-limit** | **protocol** | **source** | **traffic-class** | **version** }	Specifies a match to the IPv6 fields. The following command options are available: • **destination**—Matches to the IPv6 destination address-based fields. • **hop-limit**—Matches to the IPv6 hop limit fields. • **protocol**—Matches to the IPv6 payload protocol fields. • **source**—Matches to the IPv6 source address based fields. • **traffic-class**—Matches to the IPv6 traffic class. • **version**—Matches to the IP version from the IPv6 header.
match transport {**destination-port** | **igmp** | **icmp** | **source-port**}	Specifies a match to the Transport Layer fields. The following command options are available: • **destination-port**—Matches to the transport destination port. • **icmp**—Matches to ICMP fields, including ICMP IPv4 and IPv6 fields. • **igmp**—Matches to IGMP fields. • **source-port**—Matches to the transport source port.

Flexible NetFlow Collect Parameters

The following table describes the Flexible NetFlow collect parameters.

Table 11: Collect Parameters

Command	Purpose
collect counter { **bytes** { **layer2** { **long** } | **long** } | **packets** { **long** } }	Collects the counter fields total bytes and total packets.
collect interface {**input** | **output**}	Collects the fields from the input or output interface.
collect timestamp absolute {**first** | **last**}	Collects the fields for the absolute time the first packet was seen or the absolute time the most recent packet was last seen (in milliseconds).

Command	Purpose
collect transport tcp flags	Collects the following transport TCP flags: • **ack**—TCP acknowledgement flag • **cwr**—TCP congestion window reduced flag • **ece**—TCP ECN echo flag • **fin**—TCP finish flag • **psh**—TCP push flag • **rst**—TCP reset flag • **syn**—TCP synchronize flag • **urg**—TCP urgent flag **Note** On the device, you cannot specify which TCP flag to collect. You can only specify to collect transport TCP flags. All TCP flags will be collected with this command.
collect counter bytes	Configures the number of bytes seen in a flow as a nonkey field and enables collecting the total number of bytes from the flow.
collect counter packets	Configures the number of packets seen in a flow as a nonkey field and enables collecting the total number of packets from the flow.

Flow Exporters

Flow exporters export the data in the flow monitor cache to a remote system, such as a server running NetFlow collector, for analysis and storage. Flow exporters are created as separate entities in the configuration. Flow exporters are assigned to flow monitors to provide data export capability for the flow monitors. You can create several flow exporters and assign them to one or more flow monitors to provide several export destinations. You can create one flow exporter and apply it to several flow monitors.

NetFlow Data Export Format Version 9

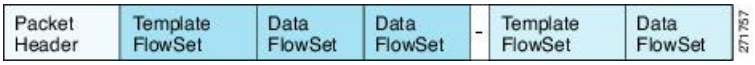
The basic output of NetFlow is a flow record. Several different formats for flow records have evolved as NetFlow has matured. The most recent evolution of the NetFlow export format is known as Version 9. The distinguishing feature of the NetFlow Version 9 export format is that it is template-based. Templates provide an extensible design to the record format, a feature that should allow future enhancements to NetFlow services without requiring concurrent changes to the basic flow-record format. Using templates provides several key benefits:

- Third-party business partners who produce applications that provide collector or display services for NetFlow do not have to recompile their applications each time a new NetFlow feature is added. Instead, they should be able to use an external data file that documents the known template formats.
- New features can be added to NetFlow quickly without breaking current implementations.

- NetFlow is “future-proofed” against new or developing protocols because the Version 9 format can be adapted to provide support for them.

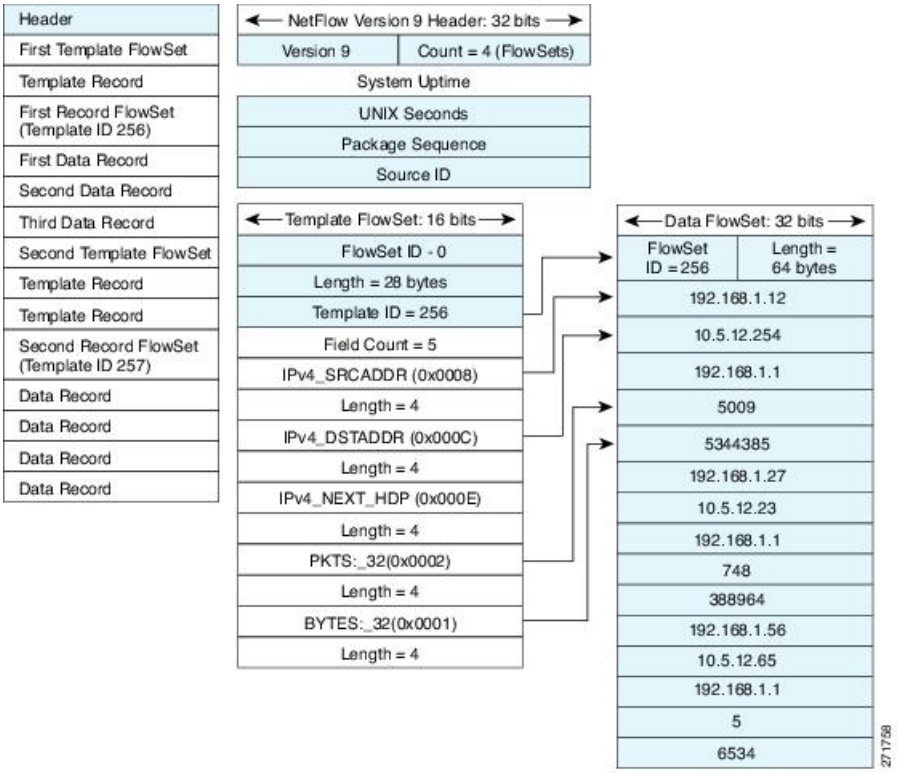
The Version 9 export format consists of a packet header followed by one or more template flow or data flow sets. A template flow set provides a description of the fields that will be present in future data flow sets. These data flow sets may occur later within the same export packet or in subsequent export packets. Template flow and data flow sets can be intermingled within a single export packet, as illustrated in the figure below.

Figure 9: Version 9 Export Packet



NetFlow Version 9 will periodically export the template data so the NetFlow collector will understand what data is to be sent and also export the data flow set for the template. The key advantage to Flexible NetFlow is that the user configures a flow record, which is effectively converted to a Version 9 template and then forwarded to the collector. The figure below is a detailed example of the NetFlow Version 9 export format, including the header, template flow, and data flow sets.

Figure 10: Detailed Example of the NetFlow Version 9 Export Format



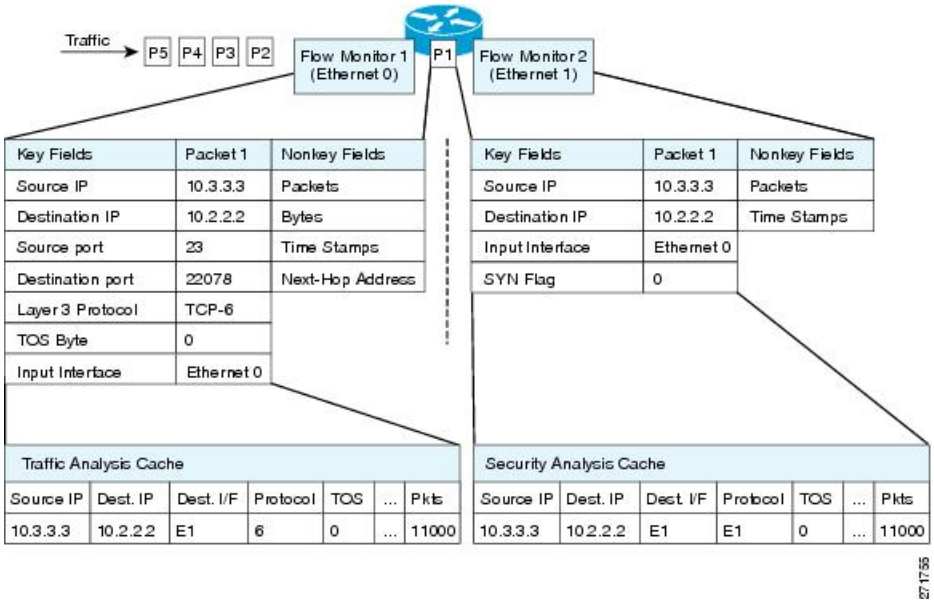
Flow Monitors

Flow monitors are the Flexible NetFlow component that is applied to interfaces to perform network traffic monitoring.

Flow data is collected from the network traffic and added to the flow monitor cache during the monitoring process based on the key and nonkey fields in the flow record.

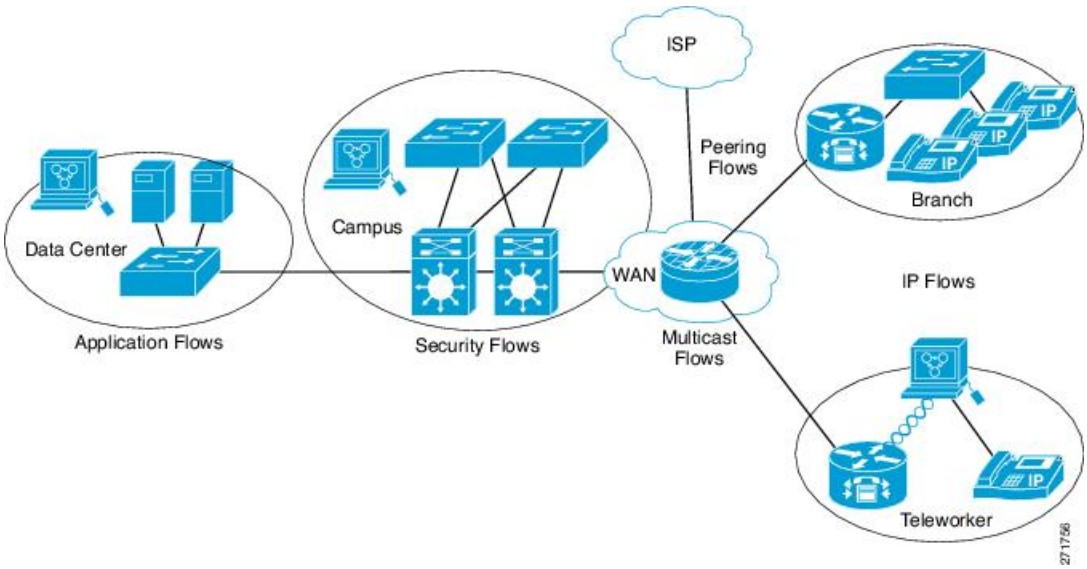
Flexible NetFlow can be used to perform different types of analysis on the same traffic. In the figure below, packet 1 is analyzed using a record designed for standard traffic analysis on the input interface and a record designed for security analysis on the output interface.

Figure 11: Example of Using Two Flow Monitors to Analyze the Same Traffic



The figure below shows a more complex example of how you can apply different types of flow monitors with custom records.

Figure 12: Complex Example of Using Multiple Types of Flow Monitors with Custom Records



Normal

The default cache type is “normal”. In this mode, the entries in the cache are aged out according to the timeout active and timeout inactive settings. When a cache entry is aged out, it is removed from the cache and exported via any exporters configured.

Flow Samplers

Flow samplers are created as separate components in a router’s configuration. Flow samplers are used to reduce the load on the device that is running Flexible NetFlow by limiting the number of packets that are selected for analysis.

Flow sampling exchanges monitoring accuracy for router performance. When you apply a sampler to a flow monitor, the overhead load on the router of running the flow monitor is reduced because the number of packets that the flow monitor must analyze is reduced. The reduction in the number of packets that are analyzed by the flow monitor causes a corresponding reduction in the accuracy of the information stored in the flow monitor’s cache.

Samplers are combined with flow monitors when they are applied to an interface with the **ip flow monitor** command.

Supported Flexible NetFlow Fields

The following tables provide a consolidated list of supported fields in Flexible NetFlow (FNF) for various traffic types and traffic direction.

Note If the packet has a VLAN field, then that length is not accounted for.

Field	Layer 2 In	Layer 2 Out	IPv4 In	IP v4 Out	IPv6 In	IPv6 Out	Notes
Key or Collect Fields							
Interface input	Yes	—	Yes	—	Yes	—	If you apply a flow monitor in the input direction: • Use the **match** keyword and use the input interface as a key field. • Use the **collect** keyword and use the output interface as a collect field. This field will be present in the exported records but with a value of 0.

Field	Layer 2 In	Layer 2 Out	IPv4 In	IP v4 Out	IPv6 In	IPv6 Out	Notes
Interface output	—	Yes	—	Yes	—	Yes	If you apply a flow monitor in the output direction: • Use the **match** keyword and use the output interface as a key field. • Use the **collect** keyword and use the input interface as a collect field. This field will be present in the exported records but with a value of 0.

Field	Layer 2 In	Layer 2 Out	IPv4 In	IP v4 Out	IPv6 In	IPv6 Out	Notes
Key Fields							
Flow direction	Yes	Yes	Yes	Yes	Yes	Yes	
Ethertype	Yes	Yes	—	—	—	—	
VLAN input	Yes	—	Yes	—	Yes	—	Supported only for a switch port.
VLAN output	—	Yes	—	Yes	—	Yes	Supported only for a switch port.
dot1q VLAN input	Yes	—	Yes	—	Yes	—	Supported only for a switch port.
dot1q VLAN output	—	Yes	—	Yes	—	Yes	Supported only for a switch port.
dot1q priority	Yes	Yes	Yes	Yes	Yes	Yes	Supported only for a switch port.
MAC source address input	Yes	Yes	Yes	Yes	Yes	Yes	

Field	Layer 2 In	Layer 2 Out	IPv4 In	IP v4 Out	IPv6 In	IPv6 Out	Notes
MAC source address output	—	—	—	—	—	—	
MAC destination address input	Yes	—	Yes	—	Yes	—	
MAC destination address output	—	Yes	—	Yes	—	Yes	
IPv4 version	—	—	Yes	Yes	Yes	Yes	
IPv4 TOS	—	—	Yes	Yes	Yes	Yes	
IPv4 protocol	—	—	Yes	Yes	Yes	Yes	Must use if any of src/dest port, ICMP code/type, IGMP type or TCP flags are used.
IPv4 TTL	—	—	Yes	Yes	Yes	Yes	
IPv4 source address	—	—	Yes	Yes	—	—	
IPv4 destination address	—	—	Yes	Yes	—	—	
ICMP IPv4 type	—	—	Yes	Yes	—	—	
ICMP IPv4 code	—	—	Yes	Yes	—	—	
IGMP type	—	—	Yes	Yes	—	—	

Field	Layer 2 In	Layer 2 Out	IPv4 In	IP v4 Out	IPv6 In	IPv6 Out	Notes
Key Fields continued							

Field	Layer 2 In	Layer 2 Out	IPv4 In	IP v4 Out	IPv6 In	IPv6 Out	Notes
IPv6 version	—	—	Yes	Yes	Yes	Yes	Same as IP version.
IPv6 protocol	—	—	Yes	Yes	Yes	Yes	Same as IP protocol. Must use if any of src/dest port, ICMP code/type, IGMP type or TCP flags are used.
IPv6 source address	—	—	—	—	Yes	Yes	
IPv6 destination address	—	—	—	—	Yes	Yes	
IPv6 traffic-class	—	—	Yes	Yes	Yes	Yes	Same as IP TOS.
IPv6 hop-limit	—	—	Yes	Yes	Yes	Yes	Same as IP TTL.
ICMP IPv6 type	—	—	—	—	Yes	Yes	
ICMP IPv6 code	—	—	—	—	Yes	Yes	
source-port	—	—	Yes	Yes	Yes	Yes	
dest-port	—	—	Yes	Yes	Yes	Yes	

Field	Layer 2 In	Layer 2 Out	IPv4 In	IP v4 Out	IPv6 In	IPv6 Out	Notes
Collect Fields							

Field	Layer 2 In	Layer 2 Out	IPv4 In	IP v4 Out	IPv6 In	IPv6 Out	Notes
Bytes long	Yes	Yes	Yes	Yes	Yes	Yes	Packet size = (Ethernet frame size including FCS - 18 bytes) **Recommended:** Avoid this field and use Bytes layer2 long.
Packets long	Yes	Yes	Yes	Yes	Yes	Yes	
Timestamp absolute first	Yes	Yes	Yes	Yes	Yes	Yes	
Timestamp absolute last	Yes	Yes	Yes	Yes	Yes	Yes	
TCP flags	Yes	Yes	Yes	Yes	Yes	Yes	Collects all flags.
Bytes layer2 long	Yes	Yes	Yes	Yes	Yes	Yes	

Default Settings

The following table lists the Flexible NetFlow default settings for the device.

Table 12: Default Flexible NetFlow Settings

Setting	Default
Flow active timeout	1800 seconds
Flow timeout inactive	15 seconds

Flexible NetFlow—Ingress VRF Support Overview

The Flexible NetFlow—Ingress VRF Support feature enables collecting the virtual routing and forwarding (VRF) ID from incoming packets on a device by applying an input flow monitor having a flow record that collects the VRF ID as a key field.

Autonomous System Number

The Autonomous System number space is a 32 bit field with 4,294,967,296 unique values, which are available for use to support the Internet's public inter-domain routing system.

An Autonomous System Number (AS number) is a special number assigned by IANA, used primarily with Border Gateway Protocol. It uniquely identifies a network under a single technical administration that has a unique routing policy, or is multi-homed to the public internet. This autonomous system number is required to run BGP and peer with your internet service provider, between internet service providers at peering points, and Internet Exchanges (IX). The AS number must be globally unique so that IP address blocks appear to come from a unique location that BGP can find and route to. BGP uses Prefixes and Autonomous System Paths (AS Paths) to determine the shortest path to a destination where a prefix is located.

NetFlow V9 and IPFIX export types support 32 bit AS number. NetFlow V5 does not support this 32 AS field, as it follows fixed 16 bit source and destination AS format.

You can export the below BGP parameters in Netflow:

- BGP source origin or peer AS number
- BGP destination origin or peer AS number

Configuration

Use the below command to configure AS number system:

[no] collect routing { **`destination | source`** } as **[[4-octet] peer] [4-octet]**

How to Configure Flexible Netflow

To configure Flexible Netflow, follow these general steps:

1. Create a flow record by specifying keys and non-key fields to the flow.
2. Create an optional flow exporter by specifying the protocol and transport destination port, destination, and other parameters.
3. Create a flow monitor based on the flow record and flow exporter.
4. Create an optional sampler.
5. Apply the flow monitor to a Layer 2 port, Layer 3 port, or VLAN.

Creating a Flow Record

Perform this task to configure a customized flow record.

Customized flow records are used to analyze traffic data for a specific purpose. A customized flow record must have at least one **match** criterion for use as the key field and typically has at least one **collect** criterion for use as a nonkey field.

There are hundreds of possible permutations of customized flow records. This task shows the steps that are used to create one of the possible permutations. Modify the steps in this task as appropriate to create a customized flow record for your requirements.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **flow record** *record-name*
4. **description** *description*
5. **match** {**ip** | **ipv6**} {**destination** | **source**} **address**
6. Repeat Step 5 as required to configure additional key fields for the record.
7. **match flow cts** {**source** | **destination**} **group-tag**
8.
9. Repeat the above step as required to configure additional nonkey fields for the record.
10. **end**
11. **show flow record** *record-name*
12. **show running-config flow record** *record-name*

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**flow record** *record-name* **Example:** `Device(config)# flow record FLOW-RECORD-1`	Creates a flow record and enters Flexible NetFlow flow record configuration mode. • This command also allows you to modify an existing flow record.
Step 4	**description** *description* **Example:** `Device(config-flow-record)# description Used for basic traffic analysis`	(Optional) Creates a description for the flow record.
Step 5	**match** {**ip**	**ipv6**} {**destination**	**source**} **address** **Example:** `Device(config-flow-record)# match ipv4 destination address`	**Note** This example configures the IPv4 destination address as a key field for the record. For information about the other key fields available for the **match ipv4** command, and the other **match** commands that are available to configure key fields.
Step 6	Repeat Step 5 as required to configure additional key fields for the record.	—

	Command or Action	Purpose

Step 7	**match flow cts** {**source** | **destination**} **group-tag**
	Example:
	`Device(config-flow-record)# match flow cts source group-tag`
	`Device(config-flow-record)# match flow cts destination group-tag`
		Note This example configures the CTS source group tag and destination group tag as a key field for the record. For information about the other key fields available for the **match ipv4**/**ipv6** command, and the other **match** commands that are available to configure key fields.
		Note
		• Ingress:
		• In an incoming packet, if a header is present, SGT will reflect the same value as the header. If no value is present, it will show zero.
		• The DGT value will not depend on the ingress port SGACL configuration.
		• Egress:
		• If either propagate SGT or CTS is disabled on the egress interface, then SGT will be zero.
		• In an outgoing packet, if SGACL configuration that corresponds to the (SGT, DGT) exists, DGT will be non-zero.
		• If SGACL is disabled on the egress port/VLAN or if global SGACL enforcement is disabled, then DGT will be zero

Step 8	**Example:**	Configures the input interface as a nonkey field for the record. **Note** This example configures the input interface as a nonkey field for the record.
Step 9	Repeat the above step as required to configure additional nonkey fields for the record.	—
Step 10	**end** **Example:** `Device(config-flow-record)# end`	Exits Flexible NetFlow flow record configuration mode and returns to privileged EXEC mode.
Step 11	**show flow record** *record-name* **Example:**	(Optional) Displays the current status of the specified flow record.

	Command or Action	Purpose
	`Device# show flow record FLOW_RECORD-1`	
Step 12	**show running-config flow record** *record-name* **Example:** `Device# show running-config flow record FLOW_RECORD-1`	(Optional) Displays the configuration of the specified flow record.

Creating a Flow Exporter

You can create a flow export to define the export parameters for a flow.

Note Each flow exporter supports only one destination. If you want to export the data to multiple destinations, you must configure multiple flow exporters and assign them to the flow monitor.

You can export to a destination using IPv4 address.

SUMMARY STEPS

1. **configure terminal**
2. **flow exporter** *name*
3. **description** *string*
4. **destination** {*ipv4-address*}
5. **dscp** *value*
6. **source** { |}
7. **transport udp** *number*
8. **ttl** *seconds*
9. **export-protocol** {**netflow-v9**}
10. **end**
11. **show flow exporter** [**name** *record-name*]
12. **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 2	**flow exporter** *name* **Example:**	Creates a flow exporter and enters flow exporter configuration mode.

	Command or Action	Purpose
	`Device(config)# flow exporter ExportTest`	
Step 3	**description** *string* **Example:** `Device(config-flow-exporter)# description ExportV9`	(Optional) Describes this flow record as a maximum 63-character string.
Step 4	**destination** {*ipv4-address*} **Example:** `Device(config-flow-exporter)# destination 192.0.2.1 (IPv4 destination)`	Sets the IPv4 destination address or hostname for this exporter.
Step 5	**dscp** *value* **Example:** `Device(config-flow-exporter)# dscp 0`	(Optional) Specifies the differentiated services codepoint value. The range is from 0 to 63. The default is 0.
Step 6	**source** { |} **Example:** `Device(config-flow-exporter)# source gigabitEthernet1/0/1`	(Optional) Specifies the interface to use to reach the NetFlow collector at the configured destination. The following interfaces can be configured as source: \
Step 7	**transport udp** *number* **Example:** `Device(config-flow-exporter)# transport udp 200`	(Optional) Specifies the UDP port to use to reach the NetFlow collector.
Step 8	**ttl** *seconds* **Example:** `Device(config-flow-exporter)# ttl 210`	(Optional) Configures the time-to-live (TTL) value for datagrams sent by the exporter. The range is from 1 to 255 seconds. The default is 255.
Step 9	**export-protocol** {**netflow-v9**} **Example:** `Device(config-flow-exporter)# export-protocol netflow-v9`	Specifies the version of the NetFlow export protocol used by the exporter.

	Command or Action	Purpose
Step 10	**end** **Example:** `Device(config-flow-record)# end`	Returns to privileged EXEC mode.
Step 11	**show flow exporter** [**name** *record-name*] **Example:** `Device# show flow exporter ExportTest`	(Optional) Displays information about NetFlow flow exporters.
Step 12	**copy running-config startup-config** **Example:** `Device# copy running-config startup-config`	(Optional) Saves your entries in the configuration file.

What to do next

Define a flow monitor based on the flow record and flow exporter.

Creating a Customized Flow Monitor

Perform this required task to create a customized flow monitor.

Each flow monitor has a separate cache assigned to it. Each flow monitor requires a record to define the contents and layout of its cache entries. These record formats can be one of the predefined formats or a user-defined format. An advanced user can create a customized format using the **flow record** command.

Note When Flexible NetFlow is configured on a Layer 3 port-channel interface, the last applied flow monitor configuration takes effect across all members of that port channel. Therefore, we recommend that you must have the same flow monitor configuration on all members of a L3 port-channel interface.

Before you begin

If you want to use a customized record instead of using one of the Flexible NetFlow predefined records, you must create the customized record before you can perform this task. If you want to add a flow exporter to the flow monitor for data export, you must create the exporter before you can complete this task.

Note You must use the **no ip flow monitor** command to remove a flow monitor from all of the interfaces to which you have applied it before you can modify the parameters for the **record** command on the flow monitor.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **flow monitor** *monitor-name*
4. **description** *description*
5. **record** {*record-name* | **netflow-original** | **netflow** {**ipv4** | **ipv6**} *record* [**peer**]}
6. **cache** {**timeout** {**active** | **inactive** | **update**} *seconds* | **type normal** }
7. Repeat Step 6 as required to finish modifying the cache parameters for this flow monitor.
8. **statistics packet protocol**
9. **statistics packet size**
10. **exporter** *exporter-name*
11. **end**
12. **show flow monitor** [[**name**] *monitor-name* [**cache** [**format** {**csv** | **record** | **table**}]] [**statistics**]]
13. **show running-config flow monitor** *monitor-name*
14. **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**flow monitor** *monitor-name* **Example:** `Device(config)# flow monitor FLOW-MONITOR-1`	Creates a flow monitor and enters Flexible NetFlow flow monitor configuration mode. • This command also allows you to modify an existing flow monitor.
Step 4	**description** *description* **Example:** `Device(config-flow-monitor)# description Used for basic ipv4 traffic analysis`	(Optional) Creates a description for the flow monitor.
Step 5	**record** {*record-name* | **netflow-original** | **netflow** {**ipv4** | **ipv6**} *record* [**peer**]} **Example:** `Device(config-flow-monitor)# record FLOW-RECORD-1`	Specifies the record for the flow monitor.

	Command or Action	Purpose

Step 6	**cache** {**timeout** {**active** | **inactive** | **update**} *seconds* | **type normal** }
	Example:
	`Device(config-flow-monitor)# cache type normal`
	`Device(config-flow-monitor)# cache timeout active`
		(Optional) Modifies the flow monitor cache parameters such as timeout values, and the cache type. Associates a flow cache with the specified flow monitor.

Step 7	Repeat Step 6 as required to finish modifying the cache parameters for this flow monitor.	—
Step 8	**statistics packet protocol** **Example:** `Device(config-flow-monitor)# statistics packet protocol`	(Optional) Enables the collection of protocol distribution statistics for Flexible NetFlow monitors.
Step 9	**statistics packet size** **Example:** `Device(config-flow-monitor)# statistics packet size`	(Optional) Enables the collection of size distribution statistics for Flexible NetFlow monitors.
Step 10	**exporter** *exporter-name* **Example:** `Device(config-flow-monitor)# exporter EXPORTER-1`	(Optional) Specifies the name of an exporter that was created previously.
Step 11	**end** **Example:** `Device(config-flow-monitor)# end`	Exits Flexible NetFlow flow monitor configuration mode and returns to privileged EXEC mode.
Step 12	**show flow monitor** [[**name**] *monitor-name* [**cache** [**format** {**csv** | **record** | **table**}]] [**statistics**]] **Example:** `Device# show flow monitor FLOW-MONITOR-2 cache`	(Optional) Displays the status and statistics for a Flexible NetFlow flow monitor.
Step 13	**show running-config flow monitor** *monitor-name* **Example:** `Device# show running-config flow monitor FLOW_MONITOR-1`	(Optional) Displays the configuration of the specified flow monitor.
Step 14	**copy running-config startup-config** **Example:**	(Optional) Saves your entries in the configuration file.

	Command or Action	Purpose
	`Device# copy running-config startup-config`	

Creating a Flow Sampler

Perform this required task to configure and enable a flow sampler.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **sampler** *sampler-name*
4. **description** *description*
5. **mode** {**random**} **1 out-of** *window-size*
6. **exit**
7. **interface** *type number*
8. {**ip** | **ipv6**} **flow monitor** *monitor-name* [[**sampler**] *sampler-name*] {**input** | **output**}
9. **end**
10. **show sampler sampler-name**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**sampler** *sampler-name* **Example:** `Device(config)# sampler SAMPLER-1`	Creates a sampler and enters sampler configuration mode. • This command also allows you to modify an existing sampler.
Step 4	**description** *description* **Example:** `Device(config-sampler)# description Sample at 50%`	(Optional) Creates a description for the flow sampler.

	Command or Action	Purpose
Step 5	**mode** {**random**} **1 out-of** *window-size* **Example:** `Device(config-sampler)# mode random 1 out-of 2`	Specifies the sampler mode and the flow sampler window size. • The range for the *window-size* argument is from 0 to 1024.
Step 6	**exit** **Example:** `Device(config-sampler)# exit`	Exits sampler configuration mode and returns to global configuration mode.
Step 7	**interface** *type number* **Example:** `Device(config)# interface GigabitEthernet 0/0/0`	Specifies an interface and enters interface configuration mode.
Step 8	{**ip** | **ipv6**} **flow monitor** *monitor-name* [[**sampler**] *sampler-name*] {**input** | **output**} **Example:** `Device(config-if)# ip flow monitor FLOW-MONITOR-1 sampler SAMPLER-1 input`	Assigns the flow monitor and the flow sampler that you created to the interface to enable sampling.
Step 9	**end** **Example:** `Device(config-if)# end`	Exits interface configuration mode and returns to privileged EXEC mode.
Step 10	**show sampler sampler-name** **Example:** `Device# show sampler SAMPLER-1`	Displays the status and statistics of the flow sampler that you configured and enabled.

Applying a Flow to an Interface

You can apply a flow monitor and an optional sampler to an interface.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface** *type*
4. {**ip flow monitor** | **ipv6 flow monitor** | **datalink flow monitor**} *name* [**sampler** *name*] {**input** | **output**}
5. **end**
6. **show flow interface** [*interface-type number*]
7. **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device(config)# configure terminal`	Enters global configuration mode.
Step 3	**interface** *type* **Example:** `Device(config)# interface GigabitEthernet1/0/1`	Enters interface configuration mode and configures an interface. Flexible NetFlow is not supported on the L2 port-channel interface, but is supported on the L2 port-channel member ports. Flexible NetFlow is supported on the L3 port-channel interfaces and member ports but not on both at the same time.
Step 4	{**ip flow monitor** | **ipv6 flow monitor** | **datalink flow monitor**} *name* [**sampler** *name*] {**input** | **output**} **Example:** `Device(config-if)# ip flow monitor MonitorTest input`	Associates an IPv4, IPv6 and datalink flow monitor, and an optional sampler to the interface for input or output packets. **ip flow monitor** – Enables Flexible NetFlow to monitor IPv4 traffic. **ipv6 flow monitor** – Enables Flexible NetFlow to monitor IPv6 traffic. **datalink flow monitor** – Enables Flexible NetFlow to monitor non-IP traffic.
Step 5	**end** **Example:** `Device(config-flow-monitor)# end`	Returns to privileged EXEC mode.
Step 6	**show flow interface** [*interface-type number*] **Example:** `Device# show flow interface`	(Optional) Displays information about NetFlow on an interface.
Step 7	**copy running-config startup-config** **Example:** `Device# copy running-config startup-config`	(Optional) Saves your entries in the configuration file.

Configuring a Bridged NetFlow on a VLAN

You can apply a flow monitor and an optional sampler to a VLAN.

SUMMARY STEPS

1. **configure terminal**
2. **vlan** [**configuration**] *vlan-id*
3. **ip flow monitor** *monitor name* [**sampler** *sampler name*] {**input** }
4. **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.

Step 2	**vlan** [**configuration**] *vlan-id*
	Example:
	`Device(config)# vlan configuration 30`
	`Device(config-vlan-config)#`
		Enters VLAN or VLAN configuration mode.

Step 3	**ip flow monitor** *monitor name* [**sampler** *sampler name*] {**input** } **Example:** `Device(config-vlan-config)# ip flow monitor MonitorTest input`	Associates a flow monitor and an optional sampler to the VLAN for input packets.
Step 4	**copy running-config startup-config** **Example:** `Device# copy running-config startup-config`	(Optional) Saves your entries in the configuration file.

Configuring Layer 2 NetFlow

You can define Layer 2 keys in Flexible NetFlow records that you can use to capture flows in Layer 2 interfaces.

SUMMARY STEPS

1. **configure terminal**

2. **flow record** *name*
3. **match datalink** {**dot1q** |**ethertype** | **mac** | **vlan**}
4. **end**
5. **show flow record** [*name*]
6. **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.

Step 2	**flow record** *name*
	Example:
	`Device(config)# flow record L2_record`
	`Device(config-flow-record)#`
		Enters flow record configuration mode.

Step 3	**match datalink** {**dot1q** |**ethertype**	**mac**	**vlan**} **Example:** `Device(config-flow-record)# match datalink ethertype`	Specifies the Layer 2 attribute as a key.
Step 4	**end** **Example:** `Device(config-flow-record)# end`	Returns to privileged EXEC mode.
Step 5	**show flow record** [*name*] **Example:** `Device# show flow record`	(Optional) Displays information about NetFlow on an interface.
Step 6	**copy running-config startup-config** **Example:** `Device# copy running-config startup-config`	(Optional) Saves your entries in the configuration file.

Monitoring Flexible NetFlow

The commands in the following table can be used to monitor Flexible NetFlow.

Table 13: Flexible NetFlow Monitoring Commands

Command	Purpose
show flow exporter [**broker** | **export-ids** | **name** | *name* | **statistics** | **templates**]	Displays information about NetFlow flow exporters and statistics.
show flow exporter [**name** *exporter-name*]	Displays information about NetFlow flow exporters and statistics.
show flow interface	Displays information about NetFlow interfaces.
show flow monitor [**name** *exporter-name*]	Displays information about NetFlow flow monitors and statistics.
show flow monitor statistics	Displays the statistics for the flow monitor
show flow monitor cache format {**table** | **record** | **csv**}	Displays the contents of the cache for the flow monitor, in the format specified.
show flow record [**name** *record-name*]	Displays information about NetFlow flow records.
show sampler [**broker** | **name** | *name*]	Displays information about NetFlow samplers.

Configuration Examples for Flexible NetFlow

Example: Configuring a Flow

This example shows how to create a flow and apply it to an interface:

```
Device# configure terminal
Enter configuration commands, one per line. End with CNTL/Z.

Device(config)# flow export export1
Device(config-flow-exporter)# destination 10.0.101.254
Device(config-flow-exporter)# transport udp 2055
Device(config-flow-exporter)# exit
Device(config)# flow record record1
Device(config-flow-record)# match ipv4 source address
Device(config-flow-record)# match ipv4 destination address
Device(config-flow-record)# match ipv4 protocol
Device(config-flow-record)# match transport source-port
Device(config-flow-record)# match transport destination-port

Device(config-flow-record)# collect counter byte long
Device(config-flow-record)# collect counter packet long
```

```
Device(config-flow-record)# collect timestamp absolute first
Device(config-flow-record)# collect timestamp absolute last
Device(config-flow-record)# exit
Device(config)# flow monitor monitor1
Device(config-flow-monitor)# record record1
Device(config-flow-monitor)# exporter export1
Device(config-flow-monitor)# exit
Device(config)# interface tenGigabitEthernet 1/0/1
Device(config-if)# ip flow monitor monitor1 input
Device(config-if)# end
```

Example: Monitoring IPv4 ingress traffic

This example shows how to monitor IPv4 ingress traffic (int g1/0/11 sends traffic to int g1/0/36 and int g3/0/11).

```
Device# configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
Device(config)# flow record  fr-1
Device(config-flow-record)# match ipv4 source address
Device(config-flow-record)# match ipv4 destination address
Device(config-flow-record)# match interface input
Device(config-flow-record)# collect counter bytes long
Device(config-flow-record)# collect counter packets long
Device(config-flow-record)# collect timestamp absolute first
Device(config-flow-record)# collect timestamp absolute last
Device(config-flow-record)# collect counter bytes layer2 long
Device(config-flow-record)# exit

Device(config)# flow exporter fe-ipfix6
Device(config-flow-exporter)# destination 2001:0:0:24::10
Device(config-flow-exporter)# source Vlan106
Device(config-flow-exporter)# transport udp 4739
Device(config-flow-exporter)# export-protocol ipfix
Device(config-flow-exporter)# template data timeout 240
Device(config-flow-exporter)# exit

Device(config)# flow exporter fe-ipfix
Device(config-flow-exporter)# description IPFIX format collector 100.0.0.80
Device(config-flow-exporter)# destination 100.0.0.80
Device(config-flow-exporter)# dscp 30
Device(config-flow-exporter)# ttl 210
Device(config-flow-exporter)# transport udp 4739
Device(config-flow-exporter)# export-protocol ipfix
Device(config-flow-exporter)# template data timeout 240
Device(config-flow-exporter)# exit

Device(config)# flow exporter fe-1
Device(config-flow-exporter)# destination 10.5.120.16
Device(config-flow-exporter)# source Vlan105
Device(config-flow-exporter)# dscp 32
Device(config-flow-exporter)# ttl 200
Device(config-flow-exporter)# transport udp 2055

Device(config-flow-exporter)# template data timeout 240
Device(config-flow-exporter)# exit

Device(config)# flow monitor fm-1
```

```
Device(config-flow-monitor)# exporter fe-ipfix6
Device(config-flow-monitor)# exporter fe-ipfix
Device(config-flow-monitor)# exporter fe-1
Device(config-flow-monitor)# cache timeout inactive 60
Device(config-flow-monitor)#  cache timeout active 180
Device(config-flow-monitor)# record fr-1
Device(config-flow-monitor)# end

Device# show running-config interface g1/0/11
Device# show running-config interface g1/0/36
Device# show running-config interface g3/0/11
Device# show flow monitor fm-1 cache format table
```

Example: Monitoring IPv4 egress traffic

```
Device# configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
Device(config)# flow record  fr-1 out
Device(config-flow-record)# match ipv4 source address
Device(config-flow-record)# match ipv4 destination address
Device(config-flow-record)# match interface output
Device(config-flow-record)# collect counter bytes long
Device(config-flow-record)# collect counter packets long
Device(config-flow-record)# collect timestamp absolute first
Device(config-flow-record)# collect timestamp absolute last
Device(config-flow-record)# exit

Device(config)# flow exporter fe-1
Device(config-flow-exporter)# destination 10.5.120.16
Device(config-flow-exporter)# source Vlan105
Device(config-flow-exporter)# dscp 32
Device(config-flow-exporter)# ttl 200
Device(config-flow-exporter)# transport udp 2055
Device(config-flow-exporter)# template data timeout 240
Device(config-flow-exporter)# exit

Device(config)# flow exporter fe-ipfix6
Device(config-flow-exporter)# destination 2001:0:0:24::10
Device(config-flow-exporter)# source Vlan106
Device(config-flow-exporter)# transport udp 4739
Device(config-flow-exporter)# export-protocol ipfix
Device(config-flow-exporter)# template data timeout 240
Device(config-flow-exporter)# exit

Device(config)# flow exporter fe-ipfix
Device(config-flow-exporter)# description IPFIX format collector 100.0.0.80
Device(config-flow-exporter)# destination 100.0.0.80
Device(config-flow-exporter)# dscp 30
Device(config-flow-exporter)# ttl 210
Device(config-flow-exporter)# transport udp 4739
Device(config-flow-exporter)# export-protocol ipfix
Device(config-flow-exporter)# template data timeout 240
Device(config-flow-exporter)# exit

Device(config)# flow monitor fm-1-output
Device(config-flow-monitor)# exporter fe-1
Device(config-flow-monitor)# exporter fe-ipfix6
Device(config-flow-monitor)# exporter fe-ipfix
```

```
Device(config-flow-monitor)# cache timeout inactive 50
Device(config-flow-monitor)#  cache timeout active 120
Device(config-flow-monitor)# record fr-1-out
Device(config-flow-monitor)# end

Device# show flow monitor fm-1-output cache format table
```

Example: Configuring Flexible NetFlow for Ingress VRF Support

The following example configures the collection of theVRF ID from incoming packets on a device by applying an input flow monitor having a flow record that collects the VRF ID as a key field.

```
Device> enable
Device# configure terminal
Device(config)# flow record rm_1
Device(config-flow-record)# match routing vrf input
Device(config-flow-record)# match ipv4 source address
Device(config-flow-record)# match ipv4 destination address
Device(config-flow-record)# collect interface input
Device(config-flow-record)# collect interface output
Device(config-flow-record)# collect counter packets
Device(config-flow-record)# exit

Device(config)# flow monitor mm_1
Device(config-flow-record)# record rm_1
Device(config-flow-record)# exit

Device(config)# interface GigabitEthernet 1/0/1
Device(config-if)# ip vrf forwarding green
Device(config-if)# ip address 172.16.2.2 255.255.255.252
Device(config-if)# ip flow monitor mm_1 input
Device(config-if)# end
```

Feature Information for Flexible NetFlow

Release	Modification
Cisco IOS XE Fuji 16.9.2	This feature was introduced.