IP SLAs Configuration Guide, Cisco IOS XE Release 2

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

CONTENTS

IP SLAs Overview

This module describes IP Service Level Agreements (SLAs). IP SLAs allows Cisco customers to analyze IP service levels for IP applications and services, to increase productivity, to lower operational costs, and to reduce the frequency of network outages. IP SLAs uses active traffic monitoring--the generation of traffic in a continuous, reliable, and predictable manner--for measuring network performance. Using IP SLAs, service provider customers can measure and provide service level agreements, and enterprise customers can verify service levels, verify outsourced service level agreements, and understand network performance. IP SLAs can perform network assessments, verify quality of service (QoS), ease the deployment of new services, and assist administrators with network troubleshooting. IP SLAs can be accessed using the Cisco software commands or Simple Network Management Protocol (SNMP) through the Cisco Round-Trip Time Monitor (RTTMON) and syslog Management Information Bases (MIBs).

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest feature information and caveats, see the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the Feature Information Table at the end of this document.

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

Information About IP SLAs

IP SLAs Technology Overview

Cisco IP SLAs uses active traffic monitoring--the generation of traffic in a continuous, reliable, and predictable manner--for measuring network performance. IP SLAs sends data across the network to measure performance between multiple network locations or across multiple network paths. It simulates network data and IP services, and collects network performance information in real time. The information collected includes data about response time, one-way latency, jitter (interpacket delay variance), packet loss, voice quality scoring, network resource availability, application performance, and server response time. IP SLAs performs active monitoring by generating and analyzing traffic to measure performance either between Cisco devices or from a Cisco device to a remote IP device such as a network application server. Measurement statistics provided by the various IP SLAs operations can be used for troubleshooting, for problem analysis, and for designing network topologies.

Using IP SLAs, service provider customers can measure and provide service level agreements, and enterprise customers can verify service levels, verify outsourced service level agreements, and understand network performance for new or existing IP services and applications. IP SLAs uses unique service level assurance metrics and methodology to provide highly accurate, precise service level assurance measurements.

Depending on the specific IP SLAs operation, statistics of delay, packet loss, jitter, packet sequence, connectivity, path, server response time, and download time can be monitored within the Cisco device and stored in both CLI and SNMP MIBs. The packets have configurable IP and application layer options such as a 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), a Virtual Private Network (VPN) routing/forwarding instance (VRF), and a URL web address.

Being Layer-2 transport independent, IP SLAs can be configured end-to-end over disparate networks to best reflect the metrics that an end-user is likely to experience. Performance metrics collected by IP SLAs operations include the following:

- 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
- Voice quality scores

Because IP SLAs is accessible using SNMP, it also can be used by performance monitoring applications like CiscoWorks Internetwork Performance Monitor (IPM) and other third-party Cisco partner performance management products. For details about network management products that use IP SLAs, see http://www.cisco.com/go/ipsla .

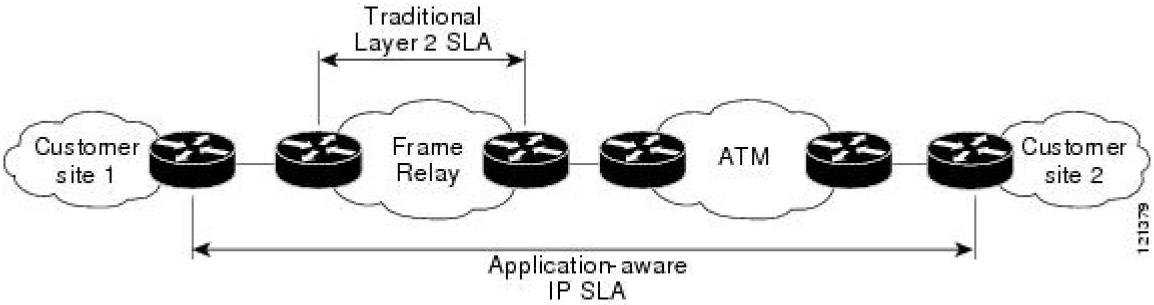
SNMP notifications based on the data gathered by an IP SLAs operation allow the router to receive alerts when performance drops below a specified level and when problems are corrected. IP SLAs uses the Cisco RTTMON MIB for interaction between external Network Management System (NMS) applications and the IP SLAs operations running on the Cisco devices. For a complete description of the object variables referenced by the IP SLAs feature, refer to the text of the CISCO-RTTMON-MIB.my file, available from the Cisco MIB website .

Service Level Agreements

Internet commerce has grown significantly in the past few years as the technology has advanced to provide faster, more reliable access to the Internet. Many companies now need online access and conduct most of their business online and any loss of service can affect the profitability of the company. Internet service providers (ISPs) and even internal IT departments now offer a defined level of service--a service level agreement--to provide their customers with a degree of predictability.

The latest performance requirements for business-critical applications, voice over IP (VoIP) networks, audio and visual conferencing, and VPNs are creating internal pressures on converged IP networks to become optimized for performance levels. Network administrators are increasingly required to support service level agreements that support application solutions. The figure below shows how IP SLAs has taken the traditional concept of Layer 2 service level agreements and applied a broader scope to support end-to-end performance measurement, including support of applications.

Figure 1: Scope of Traditional Service Level Agreement Versus IP SLAs



IP SLAs provides the following improvements over a traditional service level agreement:

- End-to-end measurements--The ability to measure performance from one end of the network to the other allows a broader reach and more accurate representation of the end-user experience.
- Sophistication--Statistics such as delay, jitter, packet sequence, Layer 3 connectivity, and path and download time that are broken down into bidirectional and round-trip numbers provide more data than just the bandwidth of a Layer 2 link.
- Ease of deployment--Leveraging the existing Cisco devices in a large network makes IP SLAs easier and cheaper to implement than the physical probes often required with traditional service level agreements.
- Application-aware monitoring--IP SLAs can simulate and measure performance statistics generated by applications running over Layer 3 through Layer 7. Traditional service level agreements can only measure Layer 2 performance.
- Pervasiveness--IP SLAs support exists in Cisco networking devices ranging from low-end to high-end routers and switches. This wide range of deployment gives IP SLAs more flexibility over traditional service level agreements.

When you know the performance expectations for different levels of traffic from the core of your network to the edge of your network, you can confidently build an end-to-end application-aware service level agreement.

Benefits of IP SLAs

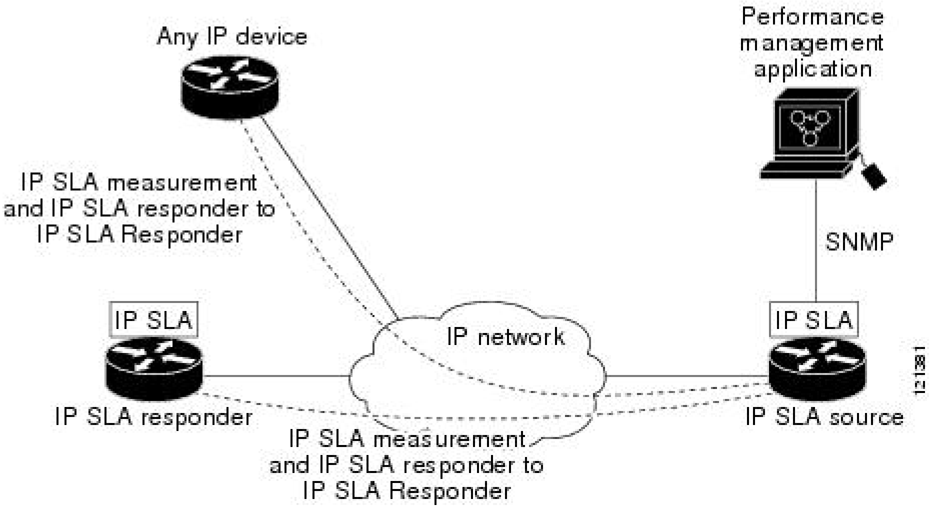
- IP SLAs monitoring
  - Provides service level agreement monitoring, measurement, and verification.
- Network performance monitoring
  - Measures the jitter, latency, or packet loss in the network.
  - Provides continuous, reliable, and predictable measurements.
- IP service network health assessment
  - Verifies that the existing QoS is sufficient for new IP services.
- Edge-to-edge network availability monitoring
  - Provides proactive verification and connectivity testing of network resources (for example, indicates the network availability of a Network File System (NFS) server used to store business critical data from a remote site).
- Troubleshooting of network operation
  - Provides consistent, reliable measurement that immediately identifies problems and saves troubleshooting time.
- Voice over IP (VoIP) performance monitoring
- Multiprotocol Label Switching (MPLS) Virtual Private Network (VPN) performance monitoring and network verification

Network Performance Measurement Using IP SLAs

Using IP SLAs, a network engineer can monitor the performance between any area in the network: core, distribution, and edge. Monitoring can be done anytime, anywhere, without deploying a physical probe.

IP SLAs uses generated traffic to measure network performance between two networking devices such as routers. The figure below shows how IP SLAs starts when the IP SLAs device sends a generated packet to the destination device. After the destination device receives the packet, and depending on the type of IP SLAs operation, the device will respond 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.

Figure 2: IP SLAs Operations


Any IP device
Performance management application
IP SLA measurement and IP SLA responder to IP SLA Responder
SNMP
IP SLA
IP network
IP SLA
121381
IP SLA responder
IP SLA source
IP SLA measurement and IP SLA responder to IP SLA Responder

To implement IP SLAs network performance measurement you need to perform these tasks:

1. Enable the IP SLAs Responder, if appropriate.
2. Configure the required IP SLAs operation type.
3. Configure any options available for the specified IP SLAs operation type.
4. Configure threshold conditions, if required.
5. Schedule the operation to run, then let the operation run for a period of time to gather statistics.
6. Display and interpret the results of the operation using Cisco software commands or an NMS system with SNMP.

Conceptual information about the IP SLAs Responder and IP SLAs control protocol, the various IP SLAs operation types, thresholding options, and scheduling options are contained in this document.

IP SLAs Operation Types

The various types of IP SLAs operations include the following:

- Data Link Switching Plus (DLSw+)
- Domain Name System (DNS)
- Dynamic Host Control Protocol (DHCP)
- File Transfer Protocol (FTP)
- Hypertext Transfer Protocol (HTTP)
- ICMP echo
- ICMP jitter
- ICMP path echo
- ICMP path jitter
- Real-Time Transport Protocol (RTP)-based VoIP
- Transmission Control Protocol (TCP) connect
- UDP echo
- UDP jitter
- UDP jitter for VoIP
- VoIP gatekeeper registration delay
- VoIP post-dial delay

IP SLAs Responder and IP SLAs Control Protocol

The IP SLAs Responder is a component embedded in the destination Cisco routing device that allows the system to anticipate and respond to IP SLAs request packets. The IP SLAs Responder provides an enormous advantage with accurate measurements without the need for dedicated probes and additional statistics not available via standard ICMP-based measurements. The patented IP SLAs Control Protocol is used by the IP SLAs Responder providing a mechanism through which the responder can be notified on which port it should listen and respond. Only a Cisco device can be a source for a destination IP SLAs Responder.

The figure "Cisco IOS XE IP SLAs Operations" in the "Network Performance Measurement Using Cisco IOS XE IP SLAs" section shows where the IP SLAs Responder fits in relation to the IP network. The IP SLAs Responder listens on a specific port for control protocol messages sent by an IP SLAs operation. Upon receipt of the control message, the responder will enable the specified UDP or TCP port for the specified duration. During this time, the responder accepts the requests and responds to them. The responder disables the port after it responds to the IP SLAs packet, or when the specified time expires. For added security, MD5 authentication for control messages is available.

Enabling the IP SLAs Responder on the destination device is not required for all IP SLAs operations. For example, if services that are already provided by the destination router (such as Telnet or HTTP) are chosen, the IP SLAs Responder need not be enabled. For non-Cisco devices, the IP SLAs Responder cannot be configured and IP SLAs can send operational packets only to services native to those devices.

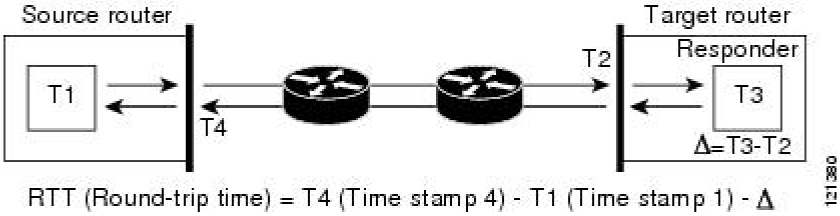
Response Time Computation for IP SLAs

Routers may take tens of milliseconds to process incoming packets, due to other high-priority processes. This delay affects the response times because the reply to test packets might be sitting on queue while waiting to be processed. In this situation, the response times would not accurately represent true network delays. IP SLAs minimizes these processing delays on the source router as well as on the target router (if IP SLAs Responder is being used), in order to determine true round-trip times. IP SLAs test packets use time stamping to minimize the processing delays.

When enabled, the IP SLAs Responder allows the target device to take two time stamps both when the packet arrives on the interface at interrupt level and again just as it is leaving, eliminating the processing time. At times of high network activity, an ICMP ping test often shows a long and inaccurate response time, while an IP SLAs test shows an accurate response time due to the time stamping on the responder.

The figure below 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.

Figure 3: IP SLAs Responder Time Stamping


Source router
Target router
Responder
T1
T2
T3
T4
Δ=T3-T2
RTT (Round-trip time) = T4 (Time stamp 4) - T1 (Time stamp 1) - Δ
121380

An additional benefit of the two time stamps at the target router 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 the configuration of both the source router and target router with Network Time Protocol (NTP) is required. Both the source and target need to be synchronized to the same clock source. One-way jitter measurements do not require clock synchronization.

IP SLAs Operation Scheduling

After an IP SLAs operation has been configured, you must schedule the operation to begin capturing statistics and collecting error information. When scheduling an operation, it can start immediately or start at a certain month, day, and hour. There is a pending option to set the operation to start at a later time. The pending option is also an internal state of the operation 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.

Multioperations scheduling allows you to schedule multiple IP SLAs operations using a single Cisco software command or the CISCO RTTMON-MIB. This feature allows you to control the amount of IP SLAs monitoring traffic by scheduling the operations to run at evenly distributed times. This distribution of

IP SLAs operations helps minimize the CPU utilization and thereby enhances the scalability of the network.

For more details about the IP SLAs multioperations scheduling functionality, see the “IP SLAs-Multioperation Scheduling of IP SLAs Operations” module of the *IP SLAs Configuration Guide* .

IP SLAs Operation Threshold Monitoring

To support successful service level agreement monitoring or to proactively measure network performance, threshold functionality becomes essential. Consistent reliable measurements immediately identify issues and can save troubleshooting time. To confidently roll out a service level agreement you need to 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

Alternately, an IP SLAs threshold violation can trigger another IP SLAs operation for further analysis. For example, the frequency could be increased or an ICMP path echo or ICMP path jitter operation could be initiated for troubleshooting.

Determining the type of threshold and the level to set can be complex, and it depends on the type of IP service being used in the network. For more details on using thresholds with IP SLAs operations, see the “IP SLAs-Proactive Threshold Monitoring of IP SLAs Operations” module of the *IP SLAs Configuration Guide* .

MPLS VPN Awareness

The IP SLAs MPLS VPN Awareness feature provides the capability to monitor IP service levels within Multiprotocol Label Switching (MPLS) Virtual Private Networks (VPNs). Using IP SLAs within MPLS VPNs allows service providers to plan, provision, and manage IP VPN services according to the service level agreement for a customer. IP SLAs operations can be configured for a specific VPN by specifying a VPN routing and forwarding (VRF) name.

History Statistics

IP SLAs maintains the following three types of history statistics:

- Aggregated statistics--By default, IP SLAs maintains two hours of aggregated statistics for each operation. Value from each operation cycle is aggregated with the previously available data within a given hour. The Enhanced History feature in IP SLAs allows for the aggregation interval to be shorter than an hour.
- Operation snapshot history--IP SLAs maintains a snapshot of data for each operation instance that matches a configurable filter, such as all, over threshold, or failures. The entire set of data is available and no aggregation takes place.
- Distribution statistics--IP SLAs maintains a frequency distribution over configurable intervals. Each time IP SLAs starts an operation, a new history bucket is created until the number of history buckets

matches the specified size or the lifetime of the operation expires. By default, the history for an IP SLAs operation is not collected. If history is collected, each bucket contains one or more history entries from the operation. History buckets do not wrap.

Additional References

Related Documents

Related Topic	Document Title
Cisco IOS commands	Cisco IOS Master Commands List, All Releases
IP SLAs commands	*IP SLAs Command Reference*

Standards

Standards	Title
ITU-T G.711 u-law and G.711 a-law	Pulse code modulation (PCM) of voice frequencies
ITU-T G.729A	Reduced complexity 8 kbit/s CS-ACELP speech codec

MIBs

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

RFCs

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

Technical Assistance

Description	Link
The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with	http://www.cisco.com/cisco/web/support/index.html

Description	Link
Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.	

Any Internet Protocol (IP) addresses and phone numbers used in this document are not intended to be actual addresses and phone numbers. Any examples, command display output, network topology diagrams, and other figures included in the document are shown for illustrative purposes only. Any use of actual IP addresses or phone numbers in illustrative content is unintentional and coincidental.

Configuring IP SLAs UDP Jitter Operations

This document describes how to configure anIP Service Level Agreements (SLAs) UDP jitter operation to analyze round-trip delay, one-way delay, one-way jitter, one-way packet loss, and connectivity in networks that carry UDP traffic in IPv4 or IPv6 networks. This module also demonstrates how the data gathered using the UDP jitter operation can be displayed and analyzed using the Cisco software commands.

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest feature information and caveats, see the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the Feature Information Table at the end of this document.

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

Prerequisites

- Time synchronization, such as that provided by NTP, is required between the source and the target device in order to provide accurate one-way delay (latency) measurements. To configure NTP on the source and target devices, perform the tasks in the “Performing Basic System Management” chapter of the `Cisco IOS XE` *Network Management* Configuration Guide. Time synchronization is not required for the one-way jitter and packet loss measurements, however. If the time is not synchronized between the source and target devices, one-way jitter and packet loss data will be returned, but values of “0” will be returned for the one-way delay measurements provided by the UDP jitter operation.

- Before configuring any IP SLAs application, you can use the **show ip sla application** command to verify that the operation type is supported on your software image.

Information About IP SLAs UDP Jitter Operations

IP SLAs UDP Jitter Operation

The IP SLAs UDP jitter operation was primarily designed to diagnose network suitability for real-time traffic applications such as voice over IP (VoIP), video over IP, or real-time conferencing.

Jitter means inter-packet delay variance. When multiple packets are sent consecutively from source to destination, for example, 10 ms apart, and if the network is behaving ideally, the destination should be receiving them 10 ms apart. But if there are delays in the network (like queuing, arriving through alternate routes, and so on) the arrival delay between packets might be greater than or less than 10 ms. Using this example, a positive jitter value indicates that the packets arrived greater than 10 ms apart. If the packets arrive 12 ms apart, then positive jitter is 2 ms; if the packets arrive 8 ms apart, then negative jitter is 2 ms. For delay-sensitive networks like VoIP, positive jitter values are undesirable, and a jitter value of 0 is ideal.

However, the IP SLAs UDP jitter operation does more than just monitor jitter. As the UDP jitter operation includes the data returned by the IP SLAs UDP operation, the UDP jitter operation can be used as a multipurpose data gathering operation. The packets IP SLAs generates carry packet sending sequence and receiving sequence information, and sending and receiving time stamps from the source and the operational target. Based on these, UDP jitter operations are capable of measuring 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)

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

The UDP jitter operation functions by generating synthetic (simulated) UDP traffic. The UDP jitter operation sends N UDP packets, each of size S, sent T milliseconds apart, from a source router to a target router, at a given frequency of F. By default, ten packet-frames (N), each with a payload size of 10 bytes (S)are generated every 10 ms (T), and the operation is repeated every 60 seconds (F). Each of these parameters are user-configurable, so as to best simulate the IP service you are providing, or want to provide, as shown in the table below.

Table 1: UDP Jitter Operation Parameters

UDP Jitter Operation Parameter	Default	Configured Using:
Number of packets (N)	10 packets	**udp-jitter** command, **num-packets** option
Payload size per packet (S)	32 bytes	**request-data-size** command

UDP Jitter Operation Parameter	Default	Configured Using:
Time between packets, in milliseconds (T)	20 ms	**udp-jitter** command, **interval** option
Elapsed time before the operation repeats, in seconds (F)	60 seconds	**frequency** (IP SLA) command

The IP SLAs operations function by generating synthetic (simulated) network traffic. A single IP SLAs operation (for example, IP SLAs operation 10) will repeat at a given frequency for the lifetime of the operation.

How to Configure IP SLAs UDP Jitter Operations

- Configuring the IP SLAs Responder on the Destination Device, page 13
- Configuring and Scheduling a UDP Jitter Operation on the Source Device, page 14

Configuring the IP SLAs Responder on the Destination Device

Note A responder should not configure a permanent port for the same sender. If the responder configures the permanent port for the same sender, even if the packets are successfully sent (no timeout or packet loss issues), the jitter values will be zero.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. Do one of the following:
   - **ip sla responder**
   - **ip sla responder udp-echo ipaddress** *ip-address* **port** *port*
4. **exit**

DETAILED STEPS

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

	Command or Action	Purpose
	Example: `Router# configure terminal`	

Step 3	Do one of the following:
	• **ip sla responder**
	• **ip sla responder udp-echo ipaddress** *ip-address* **port** *port*
	Example:
	`Router(config)# ip sla responder`
	Example:
	`Router(config)# ip sla responder udp-echo ipaddress 172.29.139.132 port 5000`
		(Optional) Temporarily enables IP SLAs Responder functionality on a Cisco device in response to control messages from source.
		or
		(Optional) Required only if protocol control is disabled on source. Permanently enables IP SLAs Responder functionality on specified IP address and port.
		• Control is enabled by default.

Step 4	**exit** **Example:** `Router(config)# exit`	(Optional) Exits global configuration mode and returns to privileged EXEC mode.

Configuring and Scheduling a UDP Jitter Operation on the Source Device

Perform only one of the following tasks:

- Configuring and Scheduling a Basic UDP Jitter Operation on the Source Device, page 14
- Configuring and Scheduling a UDP Jitter Operation with Additional Characteristics, page 16

Configuring and Scheduling a Basic 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. **exit**
9. **show ip sla configuration** [*operation-number*]

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**ip sla** *operation-number* **Example:** `Router(config)# ip sla 10`	Begins configuration for an IP SLAs 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:** `Router(config-ip-sla)# udp-jitter 172.29.139.134 5000`	Configures the IP SLAs operation as a UDP jitter operation and enters UDP jitter configuration submode. • Use the **control disable** keyword combination only if you disable the IP SLAs control protocol on both the source and target routers.
Step 5	**frequency** *seconds* **Example:** `Router(config-ip-sla-jitter)# frequency 30`	(Optional) Sets the rate at which a specified IP SLAs operation repeats.

	Command or Action	Purpose
Step 6	**exit** **Example:** `Router(config-ip-sla-jitter)# exit`	Exits UDP jitter configuration submode 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:** `Router(config)# ip sla schedule 5 start-time now life forever`	Configures the scheduling parameters for an individual IP SLAs operation.
Step 8	**exit** **Example:** `Router(config)# exit`	(Optional) Exits global configuration mode and returns to privileged EXEC mode.
Step 9	**show ip sla configuration** [*operation-number*] **Example:** `Router# show ip sla configuration 10`	(Optional) Displays configuration values including all defaults for all IP SLAs operations or a specified operation.

- Troubleshooting Tips, page 16
- What to Do Next, page 16

Troubleshooting Tips

- If the IP SLAs operation is not running and generating statistics, add the **verify-data** command to the configuration of the operation (while configuring in IP SLA configuration mode) to enable data verification. When enabled, each operation response is checked for corruption. Use the **verify-data** command with caution during normal operations because it generates unnecessary overhead.
- Use the **debugipsla trace** and **debug ip sla error** commands to help troubleshoot issues with an IP SLAs operation.

What to Do Next

To add proactive threshold conditions and reactive triggering for generating traps, or for starting another operation, to an IP SLAs operation, see the "Configuring Proactive Threshold Monitoring" section.

To view and interpret the results of an IP SLAs operation use the **show ip sla statistics** command. Checking the output for fields that correspond to criteria in your service level agreement will help you determine whether the service metrics are acceptable.

Configuring and Scheduling a UDP Jitter Operation with Additional Characteristics

Note

- The IP SLAs UDP jitter operation does not support the IP SLAs History feature (statistics history buckets) because of the large data volume involved with UDP jitter operations. This means that the following commands are not supported for UDP jitter operations: **history buckets-kept**, **history filter**, **history lives-kept**, **samples-of-history-kept**, and **show ip sla history**.
- The MIB used by IP SLAs (CISCO-RTTMON-MIB) limits the hours-of-statistics kept for the UDP jitter operation to two hours. Configuring a larger value using the **history hours-of-statistics***hours* global configuration change will not increase the value beyond two hours. However, the Data Collection MIB can be used to collect historical data for the operation. For information, see the CISCO-DATA-COLLECTION-MIB at http://www.cisco.com/go/mibs).

Before configuring a UDP jitter operation on the source device, the IP SLAs Responder must be enabled on the target device (the operational target). The IP SLAs Responder is available only on Cisco IOS software-based devices. To enable the Responder, perform the task in the “Configuring the IP SLAs Responder on the Destination Device” section.

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. **history distributions-of-statistics-kept** *size*
6. **history enhanced** [**interval** *seconds*] [**buckets** *number-of-buckets*]
7. **frequency** *seconds*
8. **history hours-of-statistics-kept** *hours*
9. **owner** *owner-id*
10. **request-data-size** *bytes*
11. **history statistics-distribution-interval** *milliseconds*
12. **tag** *text*
13. **threshold** *milliseconds*
14. **timeout** *milliseconds*
15. Do one of the following:
    - **tos** *number*
    - **traffic-class** *number*
16. **flow-label** *number*
17. **verify-data**
18. **vrf** *vrf-name*
19. **exit**
20. **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**]
21. **exit**
22. **show ip sla configuration** [*operation-number*]

DETAILED STEPS

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

	Command or Action	Purpose
Step 3	**ip sla** *operation-number* **Example:** `Router(config)# ip sla 10`	Begins configuration for an IP SLAs 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:** `Router(config-ip-sla)# udp-jitter 172.29.139.134 5000`	Configures the IP SLAs operation as a UDP jitter operation and enters UDP jitter configuration submode. - Use the **control disable** keyword combination only if you disable the IP SLAs control protocol on both the source and target routers.
Step 5	**history distributions-of-statistics-kept** *size* **Example:** `Router(config-ip-sla-jitter)# history distributions-of-statistics-kept 5`	(Optional) Sets the number of statistics distributions kept per hop during an IP SLAs operation.
Step 6	**history enhanced** [**interval** *seconds*] [**buckets** *number-of-buckets*] **Example:** `Router(config-ip-sla-jitter)# history enhanced interval 900 buckets 100`	(Optional) Enables enhanced history gathering for an IP SLAs operation.
Step 7	**frequency** *seconds* **Example:** `Router(config-ip-sla-jitter)# frequency 30`	(Optional) Sets the rate at which a specified IP SLAs operation repeats.
Step 8	**history hours-of-statistics-kept** *hours* **Example:** `Router(config-ip-sla-jitter)# history hours-of-statistics-kept 4`	(Optional) Sets the number of hours for which statistics are maintained for an IP SLAs operation.
Step 9	**owner** *owner-id* **Example:** `Router(config-ip-sla-jitter)# owner admin`	(Optional) Configures the Simple Network Management Protocol (SNMP) owner of an IP SLAs operation.
Step 10	**request-data-size** *bytes*	(Optional) Sets the protocol data size in the payload of an IP SLAs operation's request packet.

	Command or Action	Purpose
	Example: `Router(config-ip-sla-jitter)# request-data-size 64`	
Step 11	**history statistics-distribution-interval** *milliseconds* **Example:** `Router(config-ip-sla-jitter)# history statistics-distribution-interval 10`	(Optional) Sets the time interval for each statistics distribution kept for an IP SLAs operation.
Step 12	**tag** *text* **Example:** `Router(config-ip-sla-jitter)# tag TelnetPollServer1`	(Optional) Creates a user-specified identifier for an IP SLAs operation.
Step 13	**threshold** *milliseconds* **Example:** `Router(config-ip-sla-jitter)# threshold 10000`	(Optional) Sets the upper threshold value for calculating network monitoring statistics created by an IP SLAs operation.
Step 14	**timeout** *milliseconds* **Example:** `Router(config-ip-sla-jitter)# timeout 10000`	(Optional) Sets the amount of time an IP SLAs operation waits for a response from its request packet.

Step 15	Do one of the following:
	• **tos** *number*
	• **traffic-class** *number*
	Example:
	`Router(config-ip-sla-jitter)# tos 160`
	Example:
	`Router(config-ip-sla-jitter)# traffic-class 160`
		(Optional) In an IPv4 network only, defines the ToS byte in the IPv4 header of an IP SLAs operation.
		or
		(Optional) In an IPv6 network only, defines the traffic class byte in the IPv6 header for a supported IP SLAs operation.

Step 16	**flow-label** *number* **Example:** `Router(config-ip-sla-jitter)# flow-label 112233`	(Optional) In an IPv6 network only, defines the flow label field in the IPv6 header for a supported IP SLAs operation.
Step 17	**verify-data** **Example:** `Router(config-ip-sla-jitter)# verify-data`	(Optional) Causes an IP SLAs operation to check each reply packet for data corruption.

	Command or Action	Purpose
Step 18	**vrf** *vrf-name* **Example:** `Router(config-ip-sla-jitter)# vrf vpn-A`	(Optional) Allows monitoring within Multiprotocol Label Switching (MPLS) Virtual Private Networks (VPNs) using IP SLAs operations.
Step 19	**exit** **Example:** `Router(config-ip-sla-jitter)# exit`	Exits UDP jitter configuration submode and returns to global configuration mode.
Step 20	**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:** `Router(config)# ip sla schedule 5 start-time now life forever`	Configures the scheduling parameters for an individual IP SLAs operation.
Step 21	**exit** **Example:** `Router(config)# exit`	(Optional) Exits global configuration mode and returns to privileged EXEC mode.
Step 22	**show ip sla configuration** [*operation-number*] **Example:** `Router# show ip sla configuration 10`	(Optional) Displays configuration values including all defaults for all IP SLAs operations or a specified operation.

- Troubleshooting Tips, page 16
- What to Do Next, page 16

Troubleshooting Tips

- If the IP SLAs operation is not running and generating statistics, add the **verify-data** command to the configuration of the operation (while configuring in IP SLA configuration mode) to enable data verification. When enabled, each operation response is checked for corruption. Use the **verify-data** command with caution during normal operations because it generates unnecessary overhead.
- Use the **debugipsla trace** and **debug ip sla error** commands to help troubleshoot issues with an IP SLAs operation.

What to Do Next

To add proactive threshold conditions and reactive triggering for generating traps, or for starting another operation, to an IP SLAs operation, see the "Configuring Proactive Threshold Monitoring" section.

To view and interpret the results of an IP SLAs operation use the **show ip sla statistics** command. Checking the output for fields that correspond to criteria in your service level agreement will help you determine whether the service metrics are acceptable.

Configuration Examples for IP SLAs UDP Jitter Operations

Example Configuring a UDP Jitter Operation

In the following example, two operations are configured as UDP jitter operations, with operation 2 starting five seconds after the first operation. Both operations will run indefinitely.

```
ip sla 1
 udp-jitter 20.0.10.3 65051 num-packets 20
 request-data-size 160
 tos 128
 frequency 30
ip sla schedule 1 start-time after 00:05:00
ip sla 2
 udp-jitter 20.0.10.3 65052 num-packets 20 interval 10
 request-data-size 20
 tos 64
 frequency 30
ip sla schedule 2 start-time after 00:05:05
```

On the target (destination) device:

```
ip sla responder
```

Additional References

Related Documents

Related Topic	Document Title
Cisco IOS commands	Cisco IOS Master Commands List, All Releases
Cisco IOS IP SLAs commands	*Cisco IOS IP SLAs Command Reference*

Standards

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

MIBs

MIBs	MIBs Link
• CISCO-RTTMON-MIB • IPV6-FLOW-LABEL-MIB	To locate and download MIBs for selected platforms, Cisco IOS releases, and feature sets, use Cisco MIB Locator found at the following URL: http://www.cisco.com/go/mibs

RFCs

RFCs	Title
No specific RFCs are supported by the features in this document.	--

Technical Assistance

Description	Link
The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.	http://www.cisco.com/cisco/web/support/index.html

Feature Information for IP SLAs UDP Jitter Operations

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 http://www.cisco.com/go/cfn. An account on Cisco.com is not required.

Table 2: Feature Information for the IP SLAs UDP Jitter Operation

Feature Name	Releases	Feature Information
IP SLAs UDP Jitter Operation	Cisco IOS XE Release 2.1	The IP SLAs User Datagram Protocol (UDP) jitter operation allows you to measure round-trip delay, one-way delay, one-way jitter, one-way packet loss, and

Feature Name	Releases	Feature Information
		connectivity in networks that carry UDP traffic.
IP SLAs for IPv6 (UDP Jitter, UDP Echo, ICMP Echo, TCP Connect)	Cisco IOS XE Release 2.1	Support was added for operability in IPv6 networks.

Configuring IP SLAs UDP Jitter Operations for VoIP

This document describes how to configure an IP Service Level Agreements (SLAs) User Datagram Protocol (UDP jitter operation to proactively monitor Voice over IP (VoIP) quality levels in your network, allowing you to guarantee VoIP quality levels to your users in IPv4 or IPv6 networks. The IP SLAs VoIP UDP jitter operation accurately simulates VoIP traffic using common codecs, and calculates consistent voice quality scores (MOS and ICPIF) between Cisco devices in the network.

Note The term “Voice” in this document should be taken to mean any Internet telephony applications. The term “Voice over IP” can include the transmission of multimedia (both voice and video) over IP networks.

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest feature information and caveats, see the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the Feature Information Table at the end of this document.

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

Restrictions for IP SLAs UDP Jitter Operations for VoIP

- This feature uses UDP traffic to generate approximate Voice over IP scores. It does not provide support for the Real-Time Transport Protocol (RTP).
- ICPIF and MOS values provided by this feature, while consistent within IP SLAs, are estimates only and are intended only for relative comparisons. The values may not match values determined using other methods.
- Predictions of customer opinion (such as those listed for the E-Model transmission rating factor R and derived Mean Opinion Scores) determined by any method are intended only for transmission planning and analysis purposes and should not be interpreted as reflecting actual customer opinions.

Information About IP SLAs UDP Jitter Operations for VoIP

The Calculated Planning Impairment Factor (ICPIF)

The ICPIF originated in the 1996 version of ITU-T recommendation G.113, “Transmission impairments,” as part of the formula *Icpif = Itot - A*. ICPIF is actually an acronym for “(Impairment) Calculated Planning Impairment Factor,” but should be taken to simply mean the “calculated planning impairment factor.” The ICPIF attempts to quantify, for comparison and planning purposes, the key impairments to voice quality that are encountered in the network.

The ICPIF is the sum of measured impairment factors (total impairments, or *Itot*) minus a user-defined access Advantage Factor (*A*) that is intended to represent the user’s expectations, based on how the call was placed (for example, a mobile call versus a land-line call). In its expanded form, the full formula is expressed as:

Icpif = Io + Iq + Idte + Idd + Ie - A

where

- *Io* represents impairments caused by non-optimal loudness rating,
- *Iq* represents impairments caused by PCM quantizing distortion,
- *Idte* represents impairments caused by talker echo,
- *Idd* represents impairments caused by one-way transmission times (one-way delay),
- *Ie* represents impairments caused by equipment effects, such as the type of codec used for the call and packet loss, and
- *A* represents an access Advantage Factor (also called the user Expectation Factor) that compensates for the fact that users may accept some degradation in quality in return for ease of access.

ICPIF values are expressed in a typical range of 5 (very low impairment) to 55 (very high impairment). ICPIF values numerically less than 20 are generally considered “adequate.” While intended to be an objective measure of voice quality, the ICPIF value is also used to predict the subjective effect of combinations of impairments. The table below, taken from G.113 (02/96), shows how sample ICPIF values are expected to correspond to subjective quality judgement.

Table 3: Quality Levels as a Function of Total Impairment Factor ICPIF

Upper Limit for ICPIF	**Speech Communication Quality**
5	Very good
10	Good
20	Adequate
30	Limiting case
45	Exceptional limiting case
55	Customers likely to react strongly (complaints, change of network operator)

For further details on the ICPIF, see the 1996 version of the G.113 specification.

Note The latest version of the ITU-T G.113 Recommendation (2001), no longer includes the ICPIF model. Instead, it refers implementers to G.107: “The Impairment Factor method, used by the E-model of ITU-T G.107, is now recommended. The earlier method that used Quantization Distortion Units is no longer recommended.” The full E-Model (also called the ITU-T Transmission Rating Model), expressed as *R = Ro - Is - Id - Ie + A* , provides the potential for more accurate measurements of call quality by refining the definitions of impairment factors (see the 2003 version of the G.107 for details). Though the ICPIF shares terms for impairments with the E-Model, the two models should not be confused. The IP SLAs VoIP UDP Operation feature takes advantage of observed correspondences between the ICPIF, transmission rating factor R, and MOS values, but does not yet support the E-Model.

IP SLAs uses a simplified ICPIF formula, defined in more detail later in this document.

Mean Opinion Scores (MOS)

The quality of transmitted speech is a subjective response of the listener. Each codec used for transmission of Voice over IP provides a certain level of quality. A common benchmark used to determine the quality of sound produced by specific codecs is MOS. With MOS, a wide range of listeners have judged the quality of voice samples sent using particular codecs, on a scale of 1 (poor quality) to 5 (excellent quality). The opinion scores are averaged to provide the mean for each sample. The table below shows MOS ratings and the corresponding description of quality for each value.

Table 4: MOS Ratings

Score	**Quality**	**Description of Quality Impairment**
5	Excellent	Imperceptible
4	Good	Just perceptible, but not annoying
3	Fair	Perceptible and slightly annoying

Score	Quality	Description of Quality Impairment
2	Poor	Annoying but not objectionable
1	Bad	Very annoying and objectionable

As the MOS ratings for codecs and other transmission impairments are known, an estimated MOS can be computed and displayed based on measured impairments. This estimated value is designated as MOS-CQE (Mean Opinion Score; Conversational Quality, Estimated) by the ITU in order to distinguish it from objective or subjective MOS values (see P.800.1 for details).

Voice Performance Monitoring Using IP SLAs

One of the key metrics in measuring voice and video quality over an IP network is jitter. Jitter is the name used to indicate the variation in delay between arriving packets (inter-packet delay variance). Jitter affects voice quality by causing uneven gaps in the speech pattern of the person talking. Other key performance parameters for voice and video transmission over IP networks include latency (delay) and packet loss. IP SLAs is an embedded active monitoring feature of Cisco software that provides a means for simulating and measuring these parameters in order to ensure your network is meeting or exceeding service-level agreements with your users.

IP SLAs provides a UDP jitter operation, which consists of UDP probe packets sent across the network from an origin device to a specific destination (called the operational target). This synthetic traffic is used to record the amount of jitter for the connection, as well as the round-trip time, per-direction packet loss, and one-way delay time (one-way latency). (The term “synthetic traffic” indicates that the network traffic is simulated; that is, the traffic is generated by IP SLAs.) Data, in the form of collected statistics, can be displayed for multiple tests over a user-defined period of time, allowing you to see, for example, how the network performs at different times of the day, or over the course of a week. The jitter probe has the advantage of utilizing the IP SLAs Responder to provide minimal latency at the receiving end.

The IP SLAs VoIP UDP jitter operation modifies the standard UDP jitter operation by adding the capability to return MOS and ICPIF scores in the data collected by the operation, in addition to the metrics already gathered by the UDP jitter operation. This VoIP-specific implementation provides even more useful information in determining the performance of your VoIP network, thereby improving your ability to perform network assessment, troubleshooting, and health monitoring.

Codec Simulation Within IP SLAs

The IP SLAs VoIP UDP jitter operation computes statistics by sending n UDP packets, each of size s, sent t milliseconds apart, from a given source router to a given target router, at a given frequency f. The target router must be running the IP SLAs Responder in order to process the probe operations.

To generate MOS and ICPIF scores, you specify the codec type used for the connection when configuring the VoIP UDP jitter operation. Based on the type of codec you configure for the operation, the number of packets (n), the size of each payload (s), the inter-packet time interval (t), and the operational frequency (f) will be auto-configured with default values. (See the table below for specifics.) However, you are given the option, if needed, to manually configure these parameters in the syntax of the**udp-jitter** command.

The table below shows the default parameters that are configured for the operation by codec.

Table 5: Default VoIP UDP Jitter Operation Parameters by Codec

Codec	Default Request Size (Packet Payload) (s)	Default Interval Between Packets (t)	Default Number of Packets (n)	Frequency of Probe Operations (f)
G.711 mu-Law (g711ulaw)	160 + 12 RTP bytes	20 ms	1000	Once every 1 minute
G.711 A-Law (g711alaw)	160 + 12 RTP bytes	20 ms	1000	Once every 1 minute
G.729A (g729a)	20 + 12 RTP bytes	20 ms	1000	Once every 1 minute

For example, if you configure the VoIP UDP jitter operation to use the characteristics for the g711ulaw codec, by default a probe operation will be sent once a minute (**f**). Each probe operation would consist of 1000 packets (**n**), with each packet containing 180 bytes of synthetic data (**s**), sent 20 milliseconds apart (**t**).

The IP SLAs ICPIF Value

ICPIF value computation with Cisco software is based primarily on the two main factors that can impair voice quality: delayed packets and lost packets. Because packet delay and packet loss can be measured by IP SLAs, the full ICPIF formula, *Icpif = Io + Iq + Idte + Idd + Ie - A*, is simplified by assuming the values of *Io* , *Iq* , and *Idte* are zero, resulting in the following formula:

Total Impairment Factor (Icpif) = Delay Impairment Factor (Idd) + Equipment Impairment Factor (Ie) - Expectation/Advantage Factor (A)

This means that the ICPIF value is computed by adding a Delay Impairment Factor, which is based on a measurement of delayed packets, and an Equipment Impairment Factor, which is based on a measurement of lost packets. From this sum of the total impairments measured in the network, an impairment variable (the Expectation Factor) is subtracted to yield the ICPIF.

This is the same formula used by Cisco Gateways to calculate the ICPIF for received VoIP data streams.

The Delay Impairment Factor

The Delay Impairment Factor (*Idd*) is a number based on two values. One value is fixed and is derived using the static values (as defined in the ITU standards) for Codec Delay, Look Ahead Delay, and Digital Signal Processing (DSP) Delay. The second value is variable and is based on the measured one-way delay (round-trip time measurement divided by 2). The one-way delay value is mapped to a number using a mapping table that is based on a G.107 (2002 version) analytic expression. The table below shows sample correspondences between the one-way delay measured by IP SLAs and Delay Impairment Factor values.

Table 6: Sample Correspondence of One-Way Delay to ICPIF Delay Impairment

One-Way Delay (ms)	Delay Impairment Factor
50	1
100	2
150	4

One-Way Delay (ms)	Delay Impairment Factor
200	7

The Equipment Impairment Factor

The Equipment Impairment Factor (*Ie*) is a number based on the amount of measured packet loss. The amount of measured packet loss, expressed as a percentage of total number of packets sent, corresponds an Equipment Impairment Factor that is defined by codec. The table below shows sample correspondences between the packet loss measured by IP SLAs and Equipment Impairment Factor values.

Table 7: Sample Correspondence of Measured Packet Loss to ICPIF Equipment Impairment

Packet Loss (as a percentage of total number of packets sent)	Equipment Impairment Value for PCM (G.711) Codecs	Equipment Impairment Value for the CS-ACELP (G.729A) Codec
2%	12	20
4%	22	30
6%	28	38
8%	32	42

The Expectation Factor

The Expectation Factor, also called the Advantage Factor (*A*), is intended to represent the fact that users may accept some degradation in quality in return for ease of access. For example, a mobile phone user in a hard-to-reach location may have an expectation that the connection quality will not be as good as a traditional land-line connection. This variable is also called the Advantage Factor (short for Access Advantage Factor) because it attempts to balance an increased access advantage against a decline in voice quality.

The table below, adapted from ITU-T Rec. G.113, defines a set of provisional maximum values for *A* in terms of the service provided.

Table 8: Advantage Factor Recommended Maximum Values

Communication Service	Advantage / Expectation Factor: Maximum value of A
Conventional wire-line (land-line)	0
Mobility (cellular connections) within a building	5
Mobility within a Geographical area or moving in a vehicle	10
Access to hard-to-reach location; (for example, via multi-hop satellite connections)	20

These values are only suggestions. To be meaningful, the use of the factor *A* and its selected value in a specific application should be used consistently in any planning model you adopt. However, the values in the table above should be considered as the absolute upper limits for *A* .

The default Advantage Factor for IP SLAs VoIP UDP jitter operations is always zero.

The IP SLAs MOS Value

IP SLAs uses an observed correspondence between ICPIF and MOS values to estimate an MOS value. Usage of the abbreviation MOS within the context of this feature should be taken to represent the MOS-CQE (Mean Opinion Score; Conversational Quality, Estimated).

The E model, as defined in G.107 (03/2003), predicts the subjective quality that is experienced by an average listener by combining the impairment caused by transmission parameters (such as loss and delay) into a single rating, the transmission rating factor R (the R Factor). This rating, expressed in a scale of 0 (worst) to 100 (best) can be used to predict subjective user reactions, such as the MOS. Specifically, the MOS can be obtained from the R Factor with a converting formula. Conversely, a modified inverted form can be used to calculate R Factors from MOS values.

There is also a relationship between the ICPIF value and the R Factor. IP SLAs takes advantage of this correspondence by deriving the approximate MOS score from an estimated R Factor, which, in turn, is derived from the ICPIF score. The table below shows the resulting MOS values that will be generated for corresponding ICPIF values.

Table 9: Correspondence of ICPIF Values to MOS Values

ICPIF Range	MOS	Quality Category
0 - 3	5	Best
4 - 13	4	High
14 - 23	3	Medium
24 - 33	2	Low
34 - 43	1	Poor

IP SLAs will always express the estimated MOS value as a number in the range of 1 to 5, with 5 being the best quality. A MOS value of 0 (zero) indicates that MOS data could not be generated for the operation.

How to Configure IP SLAs UDP Jitter Operations for VoIP

- Configuring and Scheduling an IP SLAs VoIP UDP Jitter Operation, page 31

Configuring and Scheduling an IP SLAs VoIP UDP Jitter Operation

Note

- Currently, IP SLAs supports only the following speech codecs (compression methods):
  - G.711 A Law (g711alaw: 64 kbps PCM compression method)
  - G.711 mu Law (g711ulaw: 64 kbps PCM compression method)
  - G.729A (g729a: 8 kbps CS-ACELP compression method)
- The following commands, available in UDP jitter configuration mode, are not valid for UDP jitter (codec) operations:
  - **history distributions-of-statistics-kept**
  - **history statistics-distribution-interval**
  - **request-data-size**
- Specifying the codec-type will configure the appropriate default values for the **codec-interval**, **codec-size**, and **codec-numpacket** options. You should not specify values for the interval, size, and number of packet options unless you have a specific reason to override the defaults (for example, approximating a different codec).
- The **show ip sla configuration** command will list the values for the “Number of statistic distribution buckets kept” and “Statistic distribution interval (milliseconds),” but these values do not apply to jitter (codec) operations.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip sla** *operation-number*
4. **udp-jitter** {*destination-ip-address* | *destination-hostname*} *destination-port* **codec** *codec-type* [**codec-numpackets** *number-of-packets*] [**codec-size** *number-of-bytes*] [**codec-interval** *milliseconds*] [**advantage-factor** *value*] [**source-ip** {*ip-address* | *hostname*}] [**source-port** *port-number*] [**control** {**enable** | **disable**}]
5. **history enhanced** [**interval** *seconds*] [**buckets** *number-of-buckets*]
6. **frequency** *seconds*
7. **history hours-of-statistics-kept** *hours*
8. **owner** *owner-id*
9. **tag** *text*
10. **threshold** *milliseconds*
11. **timeout** *milliseconds*
12. Do one of the following:
    - **tos** *number*
    - **traffic-class** *number*
13. **flow-label** *number*
14. **verify-data**
15. **vrf** *vrf-name*
16. **exit**
17. **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**]
18. **exit**
19. **show ip sla configuration** [*operation-number*]

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**ip sla** *operation-number*	Begins configuration for an IP SLAs operation and enters IP SLA configuration mode.

	Command or Action	Purpose
	Example: `Router(config)# ip sla 10`	
Step 4	**udp-jitter** {*destination-ip-address* | *destination-hostname*} *destination-port* **codec** *codec-type* [**codec-numpackets** *number-of-packets*] [**codec-size** *number-of-bytes*] [**codec-interval** *milliseconds*] [**advantage-factor** *value*] [**source-ip** {*ip-address* | *hostname*}] [**source-port** *port-number*] [**control** {**enable** | **disable**}] **Example:** `Router(config-ip-sla)# udp-jitter 209.165.200.225 16384 codec g711alaw advantage-factor 10`	Configures the operation as a jitter (codec) operation that will generate VoIP scores in addition to latency, jitter, and packet loss statistics.
Step 5	**history enhanced** [**interval** *seconds*] [**buckets** *number-of-buckets*] **Example:** `Router(config-ip-sla-jitter)# history enhanced interval 900 buckets 100`	(Optional) Enables enhanced history gathering for an IP SLAs operation.
Step 6	**frequency** *seconds* **Example:** `Router(config-ip-sla-jitter)# frequency 30`	(Optional) Sets the rate at which a specified IP SLAs operation repeats.
Step 7	**history hours-of-statistics-kept** *hours* **Example:** `Router(config-ip-sla-jitter)# history hours-of-statistics-kept 4`	(Optional) Sets the number of hours for which statistics are maintained for an IP SLAs operation.
Step 8	**owner** *owner-id* **Example:** `Router(config-ip-sla-jitter)# owner admin`	(Optional) Configures the Simple Network Management Protocol (SNMP) owner of an IP SLAs operation.
Step 9	**tag** *text* **Example:** `Router(config-ip-sla-jitter)# tag TelnetPollServer1`	(Optional) Creates a user-specified identifier for an IP SLAs operation.
Step 10	**threshold** *milliseconds*	(Optional) Sets the upper threshold value for calculating network monitoring statistics created by an IP SLAs operation.

	Command or Action	Purpose
	Example: `Router(config-ip-sla-jitter)# threshold 10000`	
Step 11	**timeout** *milliseconds* **Example:** `Router(config-ip-sla-jitter)# timeout 10000`	(Optional) Sets the amount of time an IP SLAs operation waits for a response from its request packet.

Step 12	Do one of the following:
	• **tos** *number*
	• **traffic-class** *number*
	Example:
	`Router(config-ip-sla-jitter)# tos 160`
	Example:
	`Router(config-ip-sla-jitter)# traffic-class 160`
		(Optional) In an IPv4 network only, defines the ToS byte in the IPv4 header of an IP SLAs operation.
		or
		(Optional) In an IPv6 network only, defines the traffic class byte in the IPv6 header for a supported IP SLAs operation.

Step 13	**flow-label** *number* **Example:** `Router(config-ip-sla-jitter)# flow-label 112233`	(Optional) In an IPv6 network only, defines the flow label field in the IPv6 header for a supported IP SLAs operation.
Step 14	**verify-data** **Example:** `Router(config-ip-sla-jitter)# verify-data`	(Optional) Causes an IP SLAs operation to check each reply packet for data corruption.
Step 15	**vrf** *vrf-name* **Example:** `Router(config-ip-sla-jitter)# vrf vpn-A`	(Optional) Allows monitoring within Multiprotocol Label Switching (MPLS) Virtual Private Networks (VPNs) using IP SLAs operations.
Step 16	**exit** **Example:** `Router(config-ip-sla-jitter)# exit`	Exits UDP jitter configuration submode and returns to global configuration mode.
Step 17	**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 SLAs operation.

	Command or Action	Purpose
	Example: `Router(config)# ip sla schedule 5 start-time now life forever`	
Step 18	**exit** **Example:** `Router(config)# exit`	(Optional) Exits global configuration mode and returns to privileged EXEC mode.
Step 19	**show ip sla configuration** [*operation-number*] **Example:** `Router# show ip sla configuration 10`	(Optional) Displays configuration values including all defaults for all IP SLAs operations or a specified operation.

- Troubleshooting Tips, page 16
- What to Do Next, page 16

Troubleshooting Tips

- If the IP SLAs operation is not running and generating statistics, add the **verify-data** command to the configuration of the operation (while configuring in IP SLA configuration mode) to enable data verification. When enabled, each operation response is checked for corruption. Use the **verify-data** command with caution during normal operations because it generates unnecessary overhead.
- Use the **debugipsla trace** and **debug ip sla error** commands to help troubleshoot issues with an IP SLAs operation.

What to Do Next

To add proactive threshold conditions and reactive triggering for generating traps, or for starting another operation, to an IP SLAs operation, see the "Configuring Proactive Threshold Monitoring" section.

To view and interpret the results of an IP SLAs operation use the **show ip sla statistics** command. Checking the output for fields that correspond to criteria in your service level agreement will help you determine whether the service metrics are acceptable.

Configuration Examples for IP SLAs UDP Jitter Operations for VoIP

- Example IP SLAs VoIP UDP Operation Configuration, page 37
- Example IP SLAs VoIP UDP Operation Statistics Output, page 38

Example IP SLAs VoIP UDP Operation Configuration

The following example assumes that the IP SLAs Responder is enabled on the device at 209.165.200.225.

```
Router> enable

Password:
Router# configure terminal

Enter configuration commands, one per line.  End with the end command.
Router(config)# ip sla 10
Router(config-sla)# udp-jitter 209.165.200.225 16384 codec g711alaw advantage-factor 2

Router(config-sla-jitter)# owner admin_bofh
Router(config-sla-jitter)# exit

Router(config)# ip sla schedule 10 start-time now

Router(config)# exit

Router#
Router# show running-config | begin ip sla 10

ip sla 10
 udp-jitter 209.165.200.225 16384 codec g711alaw advantage-factor 2
 owner admin_bofh
ip sla schedule 10 start-time now
 .
 .
 .
Router# show ip sla configuration 10

Entry number: 10
Owner: admin_bofh
Tag:
Type of operation to perform: jitter
Target address: 209.165.200.225
Source address: 0.0.0.0
Target port: 16384
Source port: 0
Operation timeout (milliseconds): 5000
Codec Type: g711alaw
Codec Number Of Packets: 1000
Codec Packet Size: 172
Codec Interval (milliseconds): 20
Advantage Factor: 2
Type Of Service parameters: 0x0
Verify data: No
Vrf Name:
Control Packets: enabled
Operation frequency (seconds): 60
Next Scheduled Start Time: Start Time already passed
Life (seconds): 3600
Entry Ageout (seconds): never
Status of entry (SNMP RowStatus): Active
Connection loss reaction enabled: No
Timeout reaction enabled: No
Verify error enabled: No
Threshold reaction type: Never
Threshold (milliseconds): 5000
Threshold Falling (milliseconds): 3000
Threshold Count: 5
Threshold Count2: 5
Reaction Type: None
Number of statistic hours kept: 2
Number of statistic distribution buckets kept: 1
Statistic distribution interval (milliseconds): 20
Enhanced History:
```

When a codec type is configured for a jitter operation, the standard jitter “Request size (ARR data portion),” “Number of packets,” and “Interval (milliseconds)” parameters will not be displayed in the **show**

ip sla configuration command output. Instead, values for “Codec Packet Size,” “Codec Number of Packets,” and “Codec Interval (milliseconds)” are displayed.

Example IP SLAs VoIP UDP Operation Statistics Output

Use the **show ip sla statistics** command to display Voice scores (ICPIF and MOS values) for the jitter (codec) operation.

```
Router# show ip sla statistics 10

Entry number: 10
Modification time: 12:57:45.690 UTC Sun Oct 26 2003
Number of operations attempted: 1
Number of operations skipped: 0
Current seconds left in Life: Forever
Operational state of entry: Active
Last time this entry was reset: Never
Connection loss occurred: FALSE
Timeout occurred: FALSE
Over thresholds occurred: FALSE
Latest RTT (milliseconds): 19
Latest operation start time: 12:57:45.723 Sun Oct 26 2003
Latest operation return code: OK
!
Voice Scores:
ICPIF:  20          MOS Score:  3.20
!
RTT Values:
NumOfRTT: 10     RTTAvg: 19      RTTMin: 19     RTTMax: 20
RTTSum:  191    RTTSum2: 3649
Packet Loss Values:
PacketLossSD: 0 PacketLossDS: 0
PacketOutOfSequence: 0  PacketMIA: 0    PacketLateArrival: 0
InternalError: 0        Busies: 0
Jitter Values:
NumOfJitterSamples: 9
MinOfPositivesSD: 0     MaxOfPositivesSD: 0
NumOfPositivesSD: 0     SumOfPositivesSD: 0     Sum2PositivesSD: 0
MinOfNegativesSD: 0     MaxOfNegativesSD: 0
NumOfNegativesSD: 0     SumOfNegativesSD: 0     Sum2NegativesSD: 0
MinOfPositivesDS: 1     MaxOfPositivesDS: 1
NumOfPositivesDS: 1     SumOfPositivesDS: 1     Sum2PositivesDS: 1
MinOfNegativesDS: 1     MaxOfNegativesDS: 1
NumOfNegativesDS: 1     SumOfNegativesDS: 1     Sum2NegativesDS: 1
Interarrival jitterout: 0       Interarrival jitterin: 0
One Way Values:
NumOfOW: 0
OWMinSD: 0      OWMaxSD: 0      OWSumSD: 0      OWSum2SD: 0
OWMinDS: 0      OWMaxDS: 0      OWSumDS: 0      OWSum2DS: 0
```

Additional References

Related Documents

Related Topic	Document Title
Cisco IOS commands	Cisco IOS Master Commands List, All Releases
Cisco IOS IP SLAs commands	*Cisco IOS IP SLAs Command Reference*

Related Topic	Document Title
Voice over IP (VoIP) codecs	Understanding Codecs: Complexity, Hardware Support, MOS, and Negotiation http://www.cisco.com/en/US/tech/tk1077/technologies_tech_note09186a00800b6710.shtml
Jitter in Packet Voice Networks	Understanding Jitter in Packet Voice Networks (Cisco IOS Platforms) http://www.cisco.com/en/US/tech/tk652/tk698/technologies_tech_note09186a00800945df.shtml
PSTN Fallback for Voice Gateways	SIP: Measurement-Based Call Admission Control for SIP http://www.cisco.com/en/US/docs/ios/12_2t/12_2t15/feature/guide/ftcacsip.html

Standards

Standard[1]	Title
ITU-T Recommendation G.107 (2003)	The E-model, a computation model for use in transmission planning
ITU-T Recommendation G.113 (1996)	*Transmission impairments*
ITU-T Recommendation G.113 (2001)	Transmission impairments due to speech processing
ITU-T Recommendation G.711 (1998)	*Pulse code modulation (PCM) of voice frequencies* (also known as the G.711 Voice Codec)
ITU-T Recommendation G.729 Annex A (1996)	*Reduced complexity 8 kbit/s CS-ACELP speech codec* (also known as the G.729/A/B Speech Codec)
ITU-T Recommendation P.800.1 (2003)	Mean Opinion Score (MOS) terminology

MIBs

MIB	MIB Link
CISCO-RTTMON-MIB	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

[1] **Full support by this feature for listed RFCs is not claimed. ITU Telecommunication Standards ("ITU-T Recommendations In Force") can be obtained from http://www.itu.ch. Summary definitions are available from a variety of internet sources.**

RFCs

RFC[2]	Title
RFC 768	*User Datagram Protocol*
RFC 1889	*RTP: A Transport Protocol for Real-Time Applications*

Technical Assistance

Description	Link
The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.	http://www.cisco.com/cisco/web/support/index.html

Feature Information for IP SLAs UDP Jitter Operations for VoIP

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 http://www.cisco.com/go/cfn. An account on Cisco.com is not required.

Table 10: Feature Information for the IP SLAs VoIP UDP Jitter Operation

Feature Name	Releases	Feature Information
IP SLAs UDP Jitter Operation	Cisco IOS XE Release 2.1	The IP SLAs User Datagram Protocol (UDP) jitter operation allows you to measure round-trip delay, one-way delay, one-way jitter, one-way packet loss, and connectivity in networks that carry UDP traffic.

[2] **Full support by this feature for listed RFCs is not claimed.**

Feature Name	Releases	Feature Information
IP SLAs for IPv6 (UDP Jitter, UDP Echo, ICMP Echo, TCP Connect)	Cisco IOS XE Release 2.1	Support was added for operability in IPv6 networks.

Glossary

codec --In the context of IP Telephony, a codec is a compression and decompression algorithm used to transfer voice and video data more efficiently. Voice codec types are typically referred to using the ITU recommendation number that defines the algorithm (for example, “G.711” instead of “PCM”).

CS-ACELP --The codec type defined in the reference documents G.729 and G.729A, *Coding of speech at 8 kbit/s using conjugate-structure algebraic-code-excited linear-prediction (CS-ACELP)* .

ITU --The International Telecommunication Union. The ITU is an international organization within the United Nations System where governments and the private sector coordinate global telecom networks and services. The ITU Telecommunication Standardization Sector (ITU-T), responsible for defining standards (Recommendations) covering all fields of telecommunications, is one of the three operational sectors of the ITU. The ITU web site is at http://www.itu.int.

ITU-T --ITU Telecommunication Standardization Sector. The ITU-T is one of the three operational sectors of the ITU, and is responsible for defining standards (called ITU-T Recommendations) covering all fields of telecommunications.

MOS-CQE (Mean Opinion Score; Conversational Quality, Estimated)--The score calculated by a network planning model which aims at predicting the quality in a conversational application situation. Estimates of conversational quality carried out according to ITU-T Rec. G.107, when transformed to a mean opinion score (MOS), give results in terms of MOS-CQE.[3]

PCM --The codec type defined in the reference document G.711, *Pulse code modulation (PCM) of voice frequencies* .

Any Internet Protocol (IP) addresses and phone numbers used in this document are not intended to be actual addresses and phone numbers. Any examples, command display output, network topology diagrams, and other figures included in the document are shown for illustrative purposes only. Any use of actual IP addresses or phone numbers in illustrative content is unintentional and coincidental.

[3] Definition from ITU-T Recommendation P.800.1. Used in accordance with the ITU Copyright and Disclaimer Notice.

Configuring IP SLAs LSP Health Monitor Operations

This module describes how to configure an IP Service Level Agreements (SLAs) label switched path (LSP) Health Monitor with LSP Discovery feature. LSP health monitors enable you to to proactively monitor Layer 3 Multiprotocol Label Switching (MPLS) Virtual Private Networks (VPNs). This feature provides automated end-to-end verification in the control plane and data plane for all LSPs between the participating Provider Edge (PE) routers. This end-to-end (PE-to-PE router) approach ensures that LSP connectivity is verified along the paths that customer traffic is sent. Consequently, customer-impacting network connectivity issues that occur within the MPLS core will be detected by the LSP Health Monitor. Once configured, the LSP Health Monitor will automatically create and delete IP SLAs LSP ping or LSP traceroute operations based on network topology.

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest feature information and caveats, see the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the Feature Information Table at the end of this document.

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

Prerequisites for LSP Health Monitor Operations

- The participating PE routers of an LSP Health Monitor operation must support the MPLS LSP ping feature. It is recommended that the Provider (P) routers also support the MPLS LSP Ping feature in order to obtain complete error reporting and diagnostics information.
- Ensure that the source PE router has enough memory to support the desired LSP Health Monitor functionality. Enabling the LSP discovery option can potentially have a significant impact on router memory. If there is not enough memory available during the LSP discovery process, the process will gracefully terminate and an error message will be displayed.

Note The destination PE routers of an LSP Health Monitor operation do not require the IP SLAs Responder to be enabled.

Restrictions for LSP Health Monitor Operations

- Once an LSP Health Monitor operation is started, its configuration parameters should not be changed until the operation has ended. Changing the configuration parameters while the operation is actively running could cause delays in obtaining network connectivity statistics.

Information About LSP Health Monitor Operations

Benefits of the LSP Health Monitor

- End-to-end LSP connectivity measurements across equal-cost multipaths for determining network availability or testing network connectivity in MPLS networks
- Proactive threshold monitoring through SNMP trap notifications and syslog messages
- Reduced network troubleshooting time for MPLS networks
- Scalable network error detection using fast retry capability
- Creation and deletion of IP SLAs operations based on network topology
- Discovery of Border Gateway Protocol (BGP) next hop neighbors based on local VPN routing and forwarding instances (VRFs) and global routing tables
- Multioperation scheduling of IP SLAs operations
- Pseudo-wire connectivity testing between MPLS network edges, with threshold violations and scalable operation scheduling

- Monitoring and SNMP trap alerts for round-trip time (RTT) threshold violations, connection loss, and command response timeouts

How the LSP Health Monitor Works

The LSP Health Monitor feature provides the capability to proactively monitor Layer 3 MPLS VPNs. The general process for how the LSP Health Monitor works is as follows:

1. The user configures an LSP Health Monitor operation and the BGP next hop neighbor discovery process is enabled.
   Configuring an LSP Health Monitor operation is similar to configuring a standard IP SLAs operation. To illustrate, all operation parameters for an LSP Health Monitor operation are configured after an identification number for the operation is specified. However, unlike standard IP SLAs operations, these configured parameters are then used as the base configuration for the individual IP SLAs LSP ping and LSP traceroute operations that will be created by the LSP Health Monitor. The LSP discovery process can potentially have a significant impact on the memory and CPU of the source PE router. To prevent unnecessary router performance issues, careful consideration should be taken when configuring the operational and scheduling parameters of an LSP Health Monitor operation.

   When the BGP next hop neighbor discovery process is enabled, a database of BGP next hop neighbors in use by any VRF associated with the source PE router is generated based on information from the local VRF and global routing tables. For more information about the BGP next hop neighbor discovery process, see the "Discovery of Neighboring PE Routers" section.

Note By default, only a single path between the source and destination PE routers is discovered. If the LSP discovery option is enabled, the equal-cost multipaths between the source and destination PE routers are discovered. For more information on how the LSP discovery process works, see the "LSP Discovery Process" section.

2. The user configures proactive threshold monitoring parameters for the LSP Health Monitor operation. For more information about proactive threshold monitoring, see the "Proactive Threshold Monitoring for the LSP Health Monitor" section.
   Depending on the proactive threshold monitoring configuration options chosen, SNMP trap notifications or syslog messages are generated as threshold violations are met.
3. The user configures multioperation scheduling parameters for the LSP Health Monitor operation. For more information about multioperation scheduling, see the "Multioperation Scheduling for the LSP Health Monitor" section.
   Once the LSP Health Monitor operation is started, a single IP SLAs operation is automatically created (based on parameters configured in Step 1) for each applicable PE (BGP next hop) neighbor. The IP SLAs operations will measure network connectivity between the source PE router and the discovered destination PE router. The start time and frequency of each measurement is based on the multioperation scheduling parameters defined by the user.

Addition and Deletion of IP SLAs Operations

The LSP Health Monitor receives periodic notifications about BGP next hop neighbors that have been added to or removed from a particular VPN. This information is stored in a queue maintained by the LSP Health Monitor. Based on the information in the queue and user-specified time intervals, new IP SLAs operations are automatically created for newly discovered PE routers and existing IP SLAs operations are automatically deleted for any PE routers that are no longer valid. The automatic deletion of operations can be disabled. However, disabling this function is not recommended because these operations would then need to be deleted manually.

If the LSP discovery option is enabled, creation of LSP discovery groups for newly discovered BGP next hop neighbors will follow the same process as described in the "LSP Discovery Process" section. If a BGP next hop neighbor is removed from a particular VPN, all the corresponding LSP discovery groups and their associated individual IP SLAs operations and statistics are removed from the LSP discovery group database.

Access Lists for Filtering BGP Next Hop Neighbors

Standard IP access lists can be configured to restrict the number of IP SLAs operations that are automatically created by the LSP Health Monitor. When the IP SLAs access list parameter is configured, the list of BGP next hop neighbors discovered by the LSP Health Monitor is filtered based on the conditions defined by the associated standard IP access list. In other words, the LSP Health Monitor will automatically create IP SLAs operations only for those BGP next hop neighbors with source addresses that satisfy the criteria permitted by the standard IP access list.

Unique Identifier for Each Automatically Created IP SLAs Operation

The IP SLAs operations automatically created by the LSP Health Monitor are uniquely identified by their owner field. The owner field of an operation is generated using all the parameters that can be configured for that particular operation. If the length of the owner field is longer than 255 characters, it will be truncated.

Discovery of Neighboring PE Routers

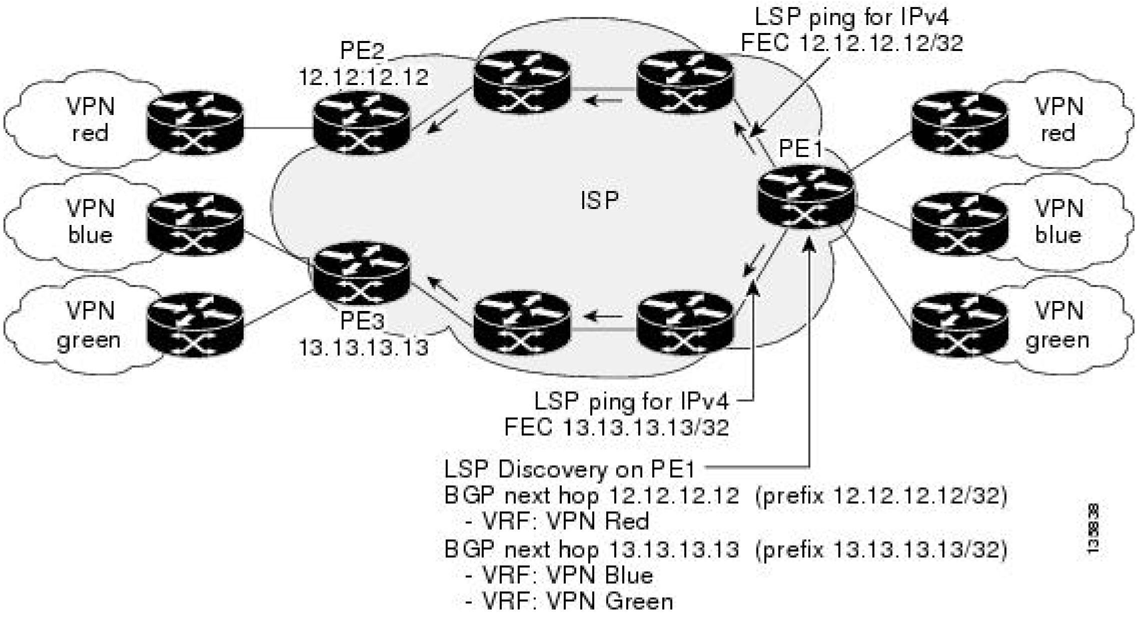
A BGP next hop neighbor discovery process is used to find the BGP next hop neighbors in use by any VRF associated with the source PE router. In most cases, these neighbors will be PE routers.

When the BGP next hop neighbor discovery process is enabled, a database of BGP next hop neighbors in use by any VRF associated with the source PE router is generated based on information from the local VRF and global routing tables. As routing updates are received, new BGP next hop neighbors are added to and deleted from the database immediately.

The figure below shows how the BGP next hop neighbor discovery process works for a simple VPN scenario for an Internet service provider (ISP). In this example, there are three VPNs associated with router PE1: red, blue, and green. From the perspective of router PE1, these VPNs are reachable remotely through BGP next hop neighbors PE2 (router ID: 12.12.12.12) and PE3 (router ID: 13.13.13.13). When the BGP next hop neighbor discovery process is enabled on router PE1, a database is generated based on the local VRF and global routing tables. The database in this example contains two BGP next hop router entries: PE2 12.12.12.12 and PE3 13.13.13.13. The routing entries are maintained per next hop router to distinguish which next hop routers belong within which particular VRF. For each next hop router entry, the IPv4

Forward Equivalence Class (FEC) of the BGP next hop router in the global routing table is provided so that it can be used by the MPLS LSP ping operation.

Figure 4: BGP Next Hop Neighbor Discovery for a Simple VPN



The LSP Discovery Process

The LSP discovery option of an LSP Health Monitor operation provides the capability to discover the equal-cost multipaths for carrying MPLS traffic between the source and destination PE routers. Network connectivity measurements can then be performed for each of the paths that were discovered.

The general process for LSP discovery is as follows:

1 BGP next hop neighbors are discovered using the BGP next hop neighbor discovery process. For more information about the BGP next hop neighbor discovery process, see the "Discovery of Neighboring PE Routers" section.
Once the LSP Health Monitor operation is started, a single IP SLAs operation is automatically created for each applicable PE (BGP next hop) neighbor. Only a single path to each applicable PE neighbor is discovered during this initial step of the LSP discovery process. For each next hop neighbor, the LSP Health Monitor creates an LSP discovery group (that initially consists of only the one discovered path) and assigns the group with a unique identification number. For more information about LSP discovery groups, see the "LSP Discovery Groups" section.

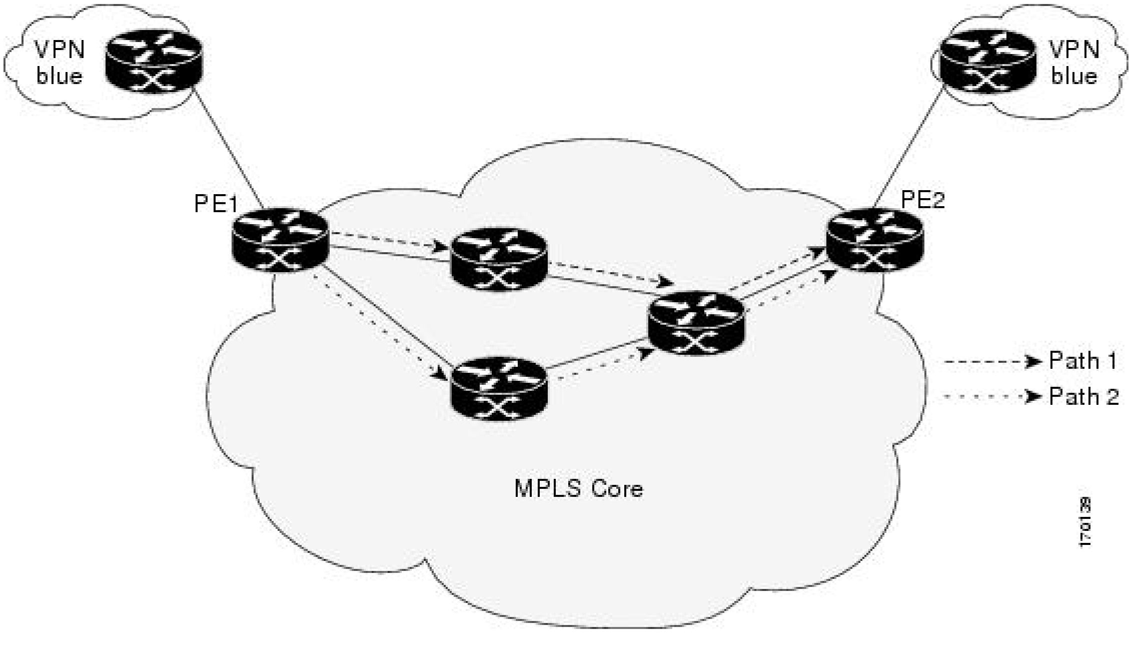
2 An LSP discovery request is sent by the LSP Health Monitor to the LSP discovery subsystem for each applicable BGP next hop neighbor. For each next hop neighbor in which an appropriate response is received, MPLS echo requests are sent one-by-one from the source PE router to discover the equal-cost multipaths. The parameters that uniquely identify each equal-cost multipath (127/8 destination IP address [LSP selector] and the PE outgoing interface) are added to the associated LSP discovery database.

Note For a given LSP Health Monitor operation, the user can define the maximum number of BGP next hop neighbors that can be concurrently undergoing LSP discovery.

3. Each individual IP SLAs operation (created for each applicable PE neighbor) uses an IP SLAs LSP ping superoperation to measure network connectivity across all equal-cost multipaths between the source PE router and discovered destination PE router. The IP SLAs superoperation operates by sending an LSP ping packet to the destination PE router and adjusting the LSP ping 127/8 LSP selector IP address for each discovered equal-cost multipath. For example, assume that there are three equal-cost multipaths to a destination PE router and the identified LSP selector IP addresses are 127.0.0.1, 127.0.0.5, and 127.0.0.6. The IP SLAs superoperation would sequentially send three LSP ping packets using the identified LSP selector IP addresses for directing the superoperation across the three paths. This technique ensures that there is only a single IP SLAs LSP ping operation for each source and destination PE router pair, and significantly reduces the number of active LSP ping operations sent by the source PE router.

The figure below illustrates a simple VPN scenario. This network consists of a core MPLS VPN with two PE routers (router PE1 and router PE2) belonging to the VRF named VPN blue. Suppose router PE1 is the source PE router for an LSP Health Monitor operation with the LSP discovery option enabled and that router PE2 is discovered by the BGP discovery process as a BGP next hop neighbor to router PE1. If path 1 and path 2 are equal-cost multipaths between router PE1 to router PE2, then the LSP discovery process would create an LSP discovery group consisting of path 1 and path 2. An IP SLAs LSP ping superoperation would also be created to monitor network availability across each path.

Figure 5: LSP Discovery for a Simple VPN

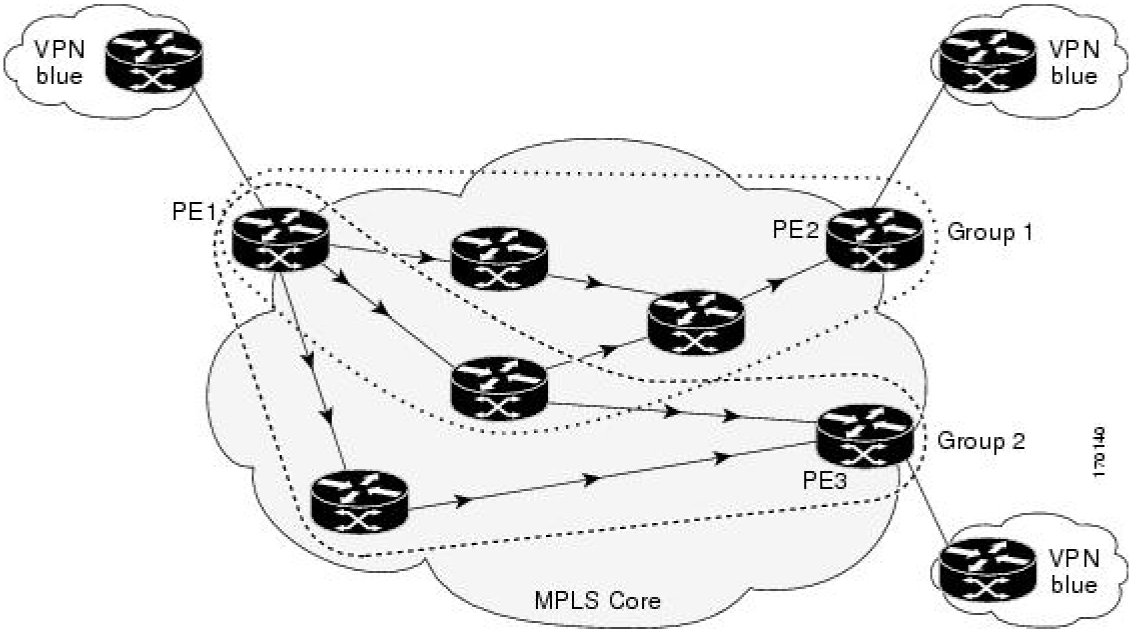


LSP Discovery Groups

A single LSP Health Monitor operation can be comprised of several LSP discovery groups depending on the number of BGP next hop neighbors discovered by the BGP next hop neighbor discovery process. Each

LSP discovery group corresponds to one BGP next hop neighbor and is assigned a unique identification number (starting with the number 1). The figure below illustrates a simple VPN scenario. This network consists of a core MPLS VPN with three PE routers (router PE1, PE2, and PE3) belonging to the VRF named VPN blue. Suppose router PE1 is the source PE router for an LSP Health Monitor operation with the LSP discovery option enabled and that router PE2 and PE3 are discovered by the BGP discovery process as BGP next hop neighbors to router PE1. LSP discovery group 1 is created for the equal-cost multipaths between router PE1 to router PE2 and LSP discovery group 2 is created for the equal-cost multipaths between router PE1 to router PE3.

Figure 6: LSP Discovery Groups for a Simple VPN



Once the LSP Health Monitor operation is started, a single IP SLAs operation is automatically created for each applicable PE (BGP next hop) neighbor. Each IP SLAs operation (created for each applicable PE neighbor) uses an IP SLAs LSP ping superoperation to measure network connectivity across all equal-cost multipaths between the source PE router and discovered destination PE router. Each LSP ping superoperation corresponds to a single LSP discovery group.

The LSP ping superoperation operates by sending an LSP ping packet to the destination PE router and adjusting the LSP ping 127/8 LSP selector IP address for each discovered equal-cost multipath. The network connectivity statistics collected by each equal-cost multipath is aggregated and stored in one-hour increments (data can be collected for a maximum of two hours). Results are stored as group averages representative of all the equal-cost multipaths within the LSP discovery group for a given one-hour increment.

Each equal-cost multipath discovered between the source PE router and a BGP next hop neighbor is uniquely identified with the following parameters:

- 127/8 destination IP address (LSP selector) within the local host IP address range
- PE outgoing interface

The database for an LSP discovery group is updated if any of the following events occur:

- The corresponding LSP ping superoperation sends an LSP ping packet.
- An active equal-cost multipath is added to or deleted from the LSP discovery group.

- The user enters the Cisco command to delete all the aggregated statistical data for a particular LSP discovery group.

IP SLAs LSP Ping and LSP Traceroute Operations

This feature introduces support for the IP SLAs LSP ping and IP SLAs LSP traceroute operations. These operations are useful for troubleshooting network connectivity issues and determining network availability in an MPLS VPN. When using the LSP Health Monitor, IP SLAs LSP ping and LSP traceroute operations are automatically created to measure network connectivity between the source PE router and the discovered destination PE routers. Individual IP SLAs LSP ping and LSP traceroute operations can also be manually configured. Manual configuration of these operations can be useful for troubleshooting a connectivity issue.

The IP SLAs LSP ping and IP SLAs LSP traceroute operations are based on the same infrastructure used by the MPLS LSP Ping and MPLS LSP Traceroute features, respectively, for sending and receiving echo reply and request packets to test LSPs.

The LSP discovery option does not support IP SLAs traceroute operations.

Proactive Threshold Monitoring for the LSP Health Monitor

Proactive threshold monitoring support for the LSP Health Monitor feature provides the capability for triggering SNMP trap notifications and syslog messages when user-defined reaction conditions (such as a connection loss or timeout) are met. Configuring threshold monitoring for an LSP Health Monitor operation is similar to configuring threshold monitoring for a standard IP SLAs operation.

LSP Discovery Option Enabled

If the LSP discovery option for an LSP Health Monitor operation is enabled, SNMP trap notifications can be generated when one of the following events occurs:

- LSP discovery for a particular BGP next hop neighbor fails.
- Operational status of an LSP discovery group changes.

Possible reasons for which LSP discovery can fail for a particular BGP next hop neighbor are as follows:

- Expiration of time allowed for a BGP next hop neighbor to respond to an LSP discovery request.
- Return code is “Broken” or “Unexplorable” for all paths leading to the BGP next hop neighbor.

The table below describes the conditions for which the operational status of an LSP discovery group can change. Whenever an individual IP SLAs LSP ping operation of an LSP discovery group is executed, a return code is generated. Depending on the value of the return code and the current status of the LSP discovery group, the group status can change.

Table 11: Conditions for Which an LSP Discovery Group Status Changes

Individual IP SLAs Operation Return Code	Current Group Status = UP	Current Group Status = PARTIAL	Current Group Status = DOWN
OK	No group status change.	If return codes for all paths in the group are OK, then the group status changes to UP.	Group status changes to PARTIAL.

Individual IP SLAs Operation Return Code	Current Group Status = UP	Current Group Status = PARTIAL	Current Group Status = DOWN
Broken or Unexplorable	Group status changes to PARTIAL.	If return codes for all paths in the group are Broken or Unexplorable, then the group status changes to DOWN.	No group status change.

The return code for an individual IP SLAs LSP ping operation can be one of the following:

- OK--Indicates that the LSP is working properly. The customer VPN traffic will be sent across this path.
- Broken--Indicates that the LSP is broken. Customer VPN traffic will not be sent across this path and may be discarded.
- Unexplorable--Indicates that not all the paths to this PE neighbor have been discovered. This may be due to a disruption along the LSP or because the number of 127/8 IP addresses used for LSP selection has been exhausted.

The status of an LSP discovery group can be one of the following:

- UNKNOWN--Indicates that group status has not yet been determined and that the paths belonging to the group are in the process of being tested for the first time. Once this initial test is complete, the group status will change to UP, PARTIAL, or DOWN.
- UP--Indicates that all the paths within the group are active and no operation failures have been detected.
- PARTIAL--Indicates that an operation failure has been detected for one or more, but not all, of the paths within the group.
- DOWN--Indicates that an operation failure has been detected for all the paths within the group.

Secondary Frequency Option

With the introduction of the LSP Health Monitor feature, a new threshold monitoring parameter has been added that allows you to specify a secondary frequency. If the secondary frequency option is configured and a failure (such as a connection loss or timeout) is detected for a particular path, the frequency at which the path is remeasured will increase to the secondary frequency value (testing at a faster rate). When the configured reaction condition is met (such as N consecutive connection losses or N consecutive timeouts), an SNMP trap and syslog message can be sent and the measurement frequency will return to its original frequency value.

Multioperation Scheduling for the LSP Health Monitor

Multioperation scheduling support for the LSP Health Monitor feature provides the capability to easily schedule the automatically created IP SLAs operations (for a given LSP Health Monitor operation) to begin at intervals equally distributed over a specified duration of time (schedule period) and to restart at a specified frequency. Multioperation scheduling is particularly useful in cases where the LSP Health Monitor is enabled on a source PE router that has a large number of PE neighbors and, therefore, a large number of IP SLAs operations running at the same time.

Newly created IP SLAs operations (for newly discovered BGP next hop neighbors) are added to the same schedule period as the operations that are currently running. To prevent too many operations from starting at the same time, the multioperation scheduling feature will schedule the operations to begin at random intervals uniformly distributed over the schedule period.

Configuring a multioperation schedule for the LSP Health Monitor is similar to configuring a standard multioperation schedule for a group of individual IP SLAs operations.

LSP Discovery Option Enabled

When a multioperation schedule for an LSP Health Monitor operation with LSP discovery is started, the BGP next hop neighbors are discovered, and network connectivity to each applicable neighbor is monitored using only a single LSP. In other words, initially, network connectivity between the source PE router and discovered destination PE router is measured across only a single path. This initial condition is the same as if an LSP Health Monitor operation was performed without LSP discovery.

Specific information about the IP SLAs LSP ping operations that are created for newly discovered equal-cost paths during the succeeding iterations of the LSP discovery process are stored in the LSP discovery group database. These newly created IP SLAs LSP ping operations will start collecting data at the next iteration of network connectivity measurements for their associated LSP discovery group.

The start times for the individual IP SLAs LSP ping operations for each LSP discovery group is based on the number of LSP discovery groups and the schedule period of the multioperation schedule. For example, if three LSP discovery groups (Group 1, Group 2, and Group 3) are scheduled to run over a period of 60 seconds, the first LSP ping operation of Group 1 will start at 0 seconds, the first LSP ping operation of Group 2 will start at 20 seconds, and the first LSP ping operation of Group 3 will start at 40 seconds. The remaining individual IP SLAs LSP ping operations for each LSP discovery group will run sequentially after completion of the first LSP ping operation. For each LSP discovery group, only one LSP ping operation runs at a time.

How to Configure LSP Health Monitor Operations

- Configuring an LSP Health Monitor Operation, page 52
- Scheduling LSP Health Monitor Operations, page 60
- Manually Configuring and Scheduling an IP SLAs LSP Ping or LSP Traceroute Operation, page 62
- Verifying and Troubleshooting LSP Health Monitor Operations, page 65

Configuring an LSP Health Monitor Operation

Perform only one of the following tasks:

- Configuring an LSP Health Monitor Operation without LSP Discovery on a PE Router, page 52
- Configuring the LSP Health Monitor Operation with LSP Discovery on a PE Router, page 57

Configuring an LSP Health Monitor Operation without LSP Discovery on a PE Router

Note If the LSP discovery option is disabled, only a single path between the source PE router and each BGP next hop neighbor is discovered.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **mpls discovery vpn next-hop**
4. **mpls discovery vpn interval** *seconds*
5. **auto ip sla mpls-lsp-monitor** *operation-number*
6. Do one of the following:
    - **type echo** [**ipsla-vrf-all** | **vrf** *vpn-name*]
    - **type pathEcho** [**ipsla-vrf-all** | **vrf** *vpn-name*]
7. **access-list** *access-list-number*
8. **scan-interval** *minutes*
9. **delete-scan-factor** *factor*
10. **force-explicit-null**
11. **exp** *exp-bits*
12. **lsp-selector** *ip-address*
13. **reply-dscp-bits** *dscp-value*
14. **reply-mode** {**ipv4** | **router-alert**}
15. **request-data-size** *bytes*
16. **secondary-frequency** {**both** | **connection-loss** | **timeout**} *frequency*
17. **tag** *text*
18. **threshold** *milliseconds*
19. **timeout** *milliseconds*
20. **ttl** *time-to-live*
21. **exit**
22. **auto ip sla mpls-lsp-monitor reaction-configuration** *operation-number* **react** {**connectionLoss** | **timeout**} [**action-type** *option*] [**threshold-type** {**consecutive** [*occurrences*] | **immediate** | **never**}]
23. **exit**

DETAILED STEPS

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

	Command or Action	Purpose
Step 3	**mpls discovery vpn next-hop** **Example:** `Router(config)# mpls discovery vpn next-hop`	(Optional) Enables the MPLS VPN BGP next hop neighbor discovery process. **Note** This command is automatically enabled when the **auto ip sla mpls-lsp-monitor** command is entered.
Step 4	**mpls discovery vpn interval** *seconds* **Example:** `Router(config)# mpls discovery vpn interval 120`	(Optional) Specifies the time interval at which routing entries that are no longer valid are removed from the BGP next hop neighbor discovery database of an MPLS VPN.
Step 5	**auto ip sla mpls-lsp-monitor** *operation-number* **Example:** `Router(config)# auto ip sla mpls-lsp-monitor 1`	Begins configuration for an LSP Health Monitor operation and enters auto IP SLA MPLS configuration mode. **Note** Entering this command automatically enables the **mpls discovery vpn next-hop** command.

Step 6	Do one of the following:
	• **type echo** [**ipsla-vrf-all** | **vrf** *vpn-name*]
	• **type pathEcho** [**ipsla-vrf-all** | **vrf** *vpn-name*]
	Example:
	`Router(config-auto-ip-sla-mpls)# type echo ipsla-vrf-all`
	Example:
	`Router(config-auto-ip-sla-mpls)# type pathEcho ipsla-vrf-all`
		Enters MPLS parameters configuration submode and allows the user to configure the parameters for an IP SLAs LSP ping operation using the LSP Health Monitor.
		or
		Enters MPLS parameters configuration submode and allows the user to configure the parameters for an IP SLAs LSP traceroute operation using the LSP Health Monitor.

Step 7	**access-list** *access-list-number* **Example:** `Router(config-auto-ip-sla-mpls-params)# access-list 10`	(Optional) Specifies the access list to apply to an LSP Health Monitor operation.
Step 8	**scan-interval** *minutes* **Example:** `Router(config-auto-ip-sla-mpls-params)# scan-interval 5`	(Optional) Sets the timer for the IP SLAs LSP Health Monitor database.
Step 9	**delete-scan-factor** *factor* **Example:** `Router(config-auto-ip-sla-mpls-params)# delete-scan-factor 2`	(Optional) Specifies the number of times the LSP Health Monitor should check the scan queue before automatically deleting IP SLAs operations for BGP next hop neighbors that are no longer valid. • The default scan factor is 1. Each time the LSP Health Monitor checks the scan queue for updates, it deletes IP SLAs

	Command or Action	Purpose
		operations for BGP next hop neighbors that are no longer valid. • If the scan factor is set to 0, IP SLAs operations will not be automatically deleted by the LSP Health Monitor. This configuration is not recommended. • This command must be used with the **scan-interval** command.
Step 10	**force-explicit-null** **Example:** `Router(config-auto-ip-sla-mpls-params)# force-explicit-null`	(Optional) Adds an explicit null label to all echo request packets of an IP SLAs operation.
Step 11	**exp** *exp-bits* **Example:** `Router(config-auto-ip-sla-mpls-params)# exp 5`	(Optional) Specifies the experimental field value in the header for an echo request packet of an IP SLAs operation.
Step 12	**lsp-selector** *ip-address* **Example:** `Router(config-auto-ip-sla-mpls-params)# lsp-selector 127.0.0.10`	(Optional) Specifies the local host IP address used to select the LSP of an IP SLAs operation.
Step 13	**reply-dscp-bits** *dscp-value* **Example:** `Router(config-auto-ip-sla-mpls-params)# reply-dscp-bits 5`	(Optional) Specifies the differentiated services codepoint (DSCP) value for an echo reply packet of an IP SLAs operation.

Step 14	**reply-mode** {**ipv4** | **router-alert**}
	Example:
	`Router(config-auto-ip-sla-mpls-params)# reply-mode router-alert`
		(Optional) Specifies the reply mode for an echo request packet of an IP SLAs operation.
		• The default reply mode is an IPv4 UDP packet.

Step 15	**request-data-size** *bytes* **Example:** `Router(config-auto-ip-sla-mpls-params)# request-data-size 200`	(Optional) Specifies the protocol data size for a request packet of an IP SLAs operation.
Step 16	**secondary-frequency** {**both** | **connection-loss** | **timeout**} *frequency*	(Optional) Sets the faster measurement frequency (secondary frequency) to which an IP SLAs operation should change when a reaction condition occurs.

	Command or Action	Purpose
	Example: `Router(config-auto-ip-sla-mpls-params)# secondary-frequency connection-loss 10`	
Step 17	**tag** *text* **Example:** `Router(config-auto-ip-sla-mpls-params)# tag testgroup`	(Optional) Creates a user-specified identifier for an IP SLAs operation.
Step 18	**threshold** *milliseconds* **Example:** `Router(config-auto-ip-sla-mpls-params)# threshold 6000`	(Optional) Sets the upper threshold value for calculating network monitoring statistics created by an IP SLAs operation.
Step 19	**timeout** *milliseconds* **Example:** `Router(config-auto-ip-sla-mpls-params)# timeout 7000`	(Optional) Specifies the amount of time the IP SLAs operation waits for a response from its request packet.
Step 20	**ttl** *time-to-live* **Example:** `Router(config-auto-ip-sla-mpls-params)# ttl 200`	(Optional) Specifies the maximum hop count for an echo request packet of an IP SLAs operation.
Step 21	**exit** **Example:** `Router(config-auto-ip-sla-mpls-params)# exit`	Exits MPLS parameters configuration submode and returns to global configuration mode.
Step 22	**auto ip sla mpls-lsp-monitor reaction-configuration** *operation-number* **react** {**connectionLoss** | **timeout**} [**action-type** *option*] [**threshold-type** {**consecutive** [*occurrences*] | **immediate** | **never**}] **Example:** `Router(config)# auto ip sla mpls-lsp-monitor reaction-configuration 1 react connectionLoss action-type trapOnly threshold-type consecutive 3`	(Optional) Configures certain actions to occur based on events under the control of the LSP Health Monitor.
Step 23	**exit**	Exits global configuration submode and returns to privileged EXEC mode.

	Command or Action	Purpose
	Example: `Router(config)# exit`	

Configuring the LSP Health Monitor Operation with LSP Discovery on a PE Router

Note

- The LSP Health Monitor with LSP Discovery feature supports Layer 3 MPLS VPNs only.
- The LSP discovery option does not support IP SLAs LSP traceroute operations.
- The LSP discovery option does not support IP SLAs VCCV operations.
- The LSP discovery process can potentially have a significant impact on the memory and CPU of the source PE router. To prevent unnecessary router performance issues, careful consideration should be taken when configuring the operational and scheduling parameters of an LSP Health Monitor operation.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **mpls discovery vpn next-hop**
4. **mpls discovery vpn interval** *seconds*
5. **auto ip sla mpls-lsp-monitor** *operation-number*
6. **type echo** [**ipsla-vrf-all** | **vrf** *vpn-name*]
7. Configure optional parameters for the IP SLAs LSP echo operation.
8. **path-discover**
9. **hours-of-statistics-kept** *hours*
10. **force-explicit-null**
11. **interval** *milliseconds*
12. **lsp-selector-base** *ip-address*
13. **maximum-sessions** *number*
14. **scan-period** *minutes*
15. **session-timeout** *seconds*
16. **timeout** *seconds*
17. **exit**
18. **exit**
19. **auto ip sla mpls-lsp-monitor reaction-configuration** *operation-number* **react lpd** {**lpd-group** [**retry** *number*] | **tree-trace**} [**action-type trapOnly**]
20. **ip sla logging traps**
21. **exit**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**mpls discovery vpn next-hop** **Example:** `Router(config)# mpls discovery vpn next-hop`	(Optional) Enables the MPLS VPN BGP next hop neighbor discovery process. **Note** This command is automatically enabled when the **auto ip sla mpls-lsp-monitor** command is entered.
Step 4	**mpls discovery vpn interval** *seconds* **Example:** `Router(config)# mpls discovery vpn interval 120`	(Optional) Specifies the time interval at which routing entries that are no longer valid are removed from the BGP next hop neighbor discovery database of an MPLS VPN.
Step 5	**auto ip sla mpls-lsp-monitor** *operation-number* **Example:** `Router(config)# auto ip sla mpls-lsp-monitor 1`	Begins configuration for an LSP Health Monitor operation and enters auto IP SLAs MPLS configuration mode. **Note** Entering this command automatically enables the **mpls discovery vpn next-hop** command.
Step 6	**type echo** [**ipsla-vrf-all** | **vrf** *vpn-name*] **Example:** `Router(config-auto-ip-sla-mpls)# type echo ipsla-vrf-all`	Enters MPLS parameters configuration mode and allows the user to configure the parameters for an IP SLAs LSP ping operation using the LSP Health Monitor.
Step 7	Configure optional parameters for the IP SLAs LSP echo operation.	(Optional) See Steps 7 through 21 in the "Configuring an LSP Health Monitor Operation Without LSP Discovery on a PE Router" section.
Step 8	**path-discover** **Example:** `Router(config-auto-ip-sla-mpls-params)# path-discover`	Enables the LSP discovery option for an IP SLAs LSP Health Monitor operation and enters LSP discovery parameters configuration submode.
Step 9	**hours-of-statistics-kept** *hours*	(Optional) Sets the number of hours for which LSP discovery group statistics are maintained for an LSP Health Monitor operation.

	Command or Action	Purpose
	Example: `Router(config-auto-ip-sla-mpls-lpd-params)# hours-of-statistics-kept 1`	
Step 10	**force-explicit-null** **Example:** `Router(config-auto-ip-sla-mpls-lpd-params)# force-explicit-null`	(Optional) Adds an explicit null label to all echo request packets of an LSP Health Monitor operation.
Step 11	**interval** *milliseconds* **Example:** `Router(config-auto-ip-sla-mpls-lpd-params)# interval 2`	(Optional) Specifies the time interval between MPLS echo requests that are sent as part of the LSP discovery process for an LSP Health Monitor operation.
Step 12	**lsp-selector-base** *ip-address* **Example:** `Router(config-auto-ip-sla-mpls-lpd-params)# lsp-selector-base 127.0.0.2`	(Optional) Specifies the base IP address used to select the LSPs belonging to the LSP discovery groups of an LSP Health Monitor operation.
Step 13	**maximum-sessions** *number* **Example:** `Router(config-auto-ip-sla-mpls-lpd-params)# maximum-sessions 2`	(Optional) Specifies the maximum number of BGP next hop neighbors that can be concurrently undergoing LSP discovery for a single LSP Health Monitor operation. **Note** Careful consideration should be used when configuring this parameter to avoid a negative impact on the router's CPU.
Step 14	**scan-period** *minutes* **Example:** `Router(config-auto-ip-sla-mpls-lpd-params)# scan-period 30`	(Optional) Sets the amount of time after which the LSP discovery process can restart for an LSP Health Monitor operation.
Step 15	**session-timeout** *seconds* **Example:** `Router(config-auto-ip-sla-mpls-lpd-params)# session-timeout 60`	(Optional) Sets the amount of time the LSP discovery process for an LSP Health Monitor operation waits for a response to its LSP discovery request for a particular BGP next hop neighbor.
Step 16	**timeout** *seconds* **Example:** `Router(config-auto-ip-sla-mpls-lpd-params)# timeout 4`	(Optional) Sets the amount of time the LSP discovery process for an LSP Health Monitor operation waits for a response to its echo request packets. **Note** Careful consideration should be used when configuring this parameter to avoid a negative impact on the router's CPU.
Step 17	**exit**	Exits LSP discovery parameters configuration submode and returns to MPLS parameters configuration mode.

	Command or Action	Purpose
	Example: `Router(config-auto-ip-sla-mpls-lpd-params)# exit`	
Step 18	**exit** **Example:** `Router(config-auto-ip-sla-mpls-params)# exit`	Exits MPLS parameters configuration mode and returns to global configuration mode.
Step 19	**auto ip sla mpls-lsp-monitor reaction-configuration** *operation-number* **react lpd** {**lpd-group** [**retry** *number*] | **tree-trace**} [**action-type trapOnly**] **Example:** `Router(config)# auto ip sla mpls-lsp-monitor reaction-configuration 1 react lpd lpd-group retry 3 action-type trapOnly`	(Optional) Configures the proactive threshold monitoring parameters for an LSP Health Monitor operation with LSP discovery enabled.
Step 20	**ip sla logging traps** **Example:** `Router(config)# ip sla logging traps`	(Optional) Enables the generation of SNMP system logging messages specific to IP SLAs trap notifications.
Step 21	**exit** **Example:** `Router(config)# exit`	Exits global configuration submode and returns to privileged EXEC mode.

Scheduling LSP Health Monitor Operations

Note

- The LSP discovery process can potentially have a significant impact on the memory and CPU of the source PE router. Careful consideration should be taken when configuring the scheduling parameters to prevent too many IP SLAs LSP ping operations from running at the same time. The schedule period should be set to a relatively large value for large MPLS VPNs.
- Newly created IP SLAs operations (for newly discovered BGP next hop neighbors) are added to the same mulioperation schedule period as the operations that are currently running. To prevent too many operations from starting at the same time, the multioperation scheduler will schedule the operations to begin at random intervals uniformly distributed over the schedule period.

- All IP SLAs operations to be scheduled must be already configured.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **auto ip sla mpls-lsp-monitor schedule** *operation-number* **schedule-period** *seconds* [**frequency** [*seconds*]] [**start-time** {**after** *hh* **:** *mm* **:** *ss* | *hh* **:** *mm*[**:** *ss*] [*month day* | *day month*] | **now** | **pending**}]
4. **exit**
5. **show ip sla configuration**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**auto ip sla mpls-lsp-monitor schedule** *operation-number* **schedule-period** *seconds* [**frequency** [*seconds*]] [**start-time** {**after** *hh* **:** *mm* **:** *ss* | *hh* **:** *mm*[**:** *ss*] [*month day* | *day month*] | **now** | **pending**}] **Example:** `Router(config)# auto ip sla mpls-lsp-monitor schedule 1 schedule-period 60 start-time now`	Configures the scheduling parameters for an LSP Health Monitor operation.
Step 4	**exit** **Example:** `Router(config)# exit`	Exits to privileged EXEC mode.
Step 5	**show ip sla configuration** **Example:** `Router# show ip sla configuration`	(Optional) Displays the IP SLAs configuration details.

- Troubleshooting Tips, page 61
- What to Do Next, page 62

Troubleshooting Tips

Use the **debug ip sla trace** and **debug ip sla error** commands to help troubleshoot issues with an individual IP SLAs LSP ping or LSP traceroute operation. Use the **debug ip sla mpls-lsp-monitor** command to help troubleshoot issues with an IP SLAs LSP Health Monitor operation.

What to Do Next

To display the results of an individual IP SLAs operation use the **show ip sla statistics** and **show ip sla statistics aggregated** commands. Checking the output for fields that correspond to criteria in your service level agreement will help you determine whether the service metrics are acceptable.

Manually Configuring and Scheduling an IP SLAs LSP Ping or LSP Traceroute Operation

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip sla** *operation-number*
4. Do one of the following:
   - **mpls lsp ping ipv4** *destination-address destination-mask* [**force-explicit-null**] [**lsp-selector** *ip-address*] [**src-ip-addr** *source-address*] [**reply** {**dscp** *dscp-value* | **mode** {**ipv4** | **router-alert**}}]
   -
   - **mpls lsp trace ipv4** *destination-address destination-mask* [**force-explicit-null**] [**lsp-selector** *ip-address*] [**src-ip-addr** *source-address*] [**reply** {**dscp** *dscp-value* | **mode** {**ipv4** | **router-alert**}}]
5. **exp** *exp-bits*
6. **request-data-size** *bytes*
7. **secondary-frequency** {**connection-loss** | **timeout**} *frequency*
8. **tag** *text*
9. **threshold** *milliseconds*
10. **timeout** *milliseconds*
11. **ttl** *time-to-live*
12. **exit**
13. **ip sla reaction-configuration** *operation-number* [**react** *monitored-element*] [**threshold-type** {**never** | **immediate** | **consecutive** [*consecutive-occurrences*] | **xofy** [*x-value y-value*] | **average** [*number-of-probes*]}] [**threshold-value** *upper-threshold lower-threshold*] [**action-type** {**none** | **trapOnly** | **triggerOnly** | **trapAndTrigger**}]
14. **ip sla logging traps**
15. **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**]
16. **exit**

DETAILED STEPS

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

	Command or Action	Purpose
	Example: `Router> enable`	
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**ip sla** *operation-number* **Example:** `Router(config)# ip sla 1`	Begins configuration for an IP SLAs operation and enters IP SLA configuration mode.

Step 4	Do one of the following:
	• **mpls lsp ping ipv4** *destination-address destination-mask* [**force-explicit-null**] [**lsp-selector** *ip-address*] [**src-ip-addr** *source-address*] [**reply** {**dscp** *dscp-value* | **mode** {**ipv4** | **router-alert**}}]
	•
	• **mpls lsp trace ipv4** *destination-address destination-mask* [**force-explicit-null**] [**lsp-selector** *ip-address*] [**src-ip-addr** *source-address*] [**reply** {**dscp** *dscp-value* | **mode** {**ipv4** | **router-alert**}}]
	Example:
	`Router(config-ip-sla)# mpls lsp ping ipv4 192.168.1.4 255.255.255.255 lsp-selector 127.1.1.1`
	Example:
	Example:
	`Router(config-ip-sla)# mpls lsp trace ipv4 192.168.1.4 255.255.255.255 lsp-selector 127.1.1.1`
		Configures the IP SLAs operation as an LSP ping operation and enters LSP ping configuration mode.
		or
		Configures the IP SLAs operation as an LSP trace operation and enters LSP trace configuration mode.

Step 5	**exp** *exp-bits* **Example:** `Router(config-sla-monitor-lspPing)# exp 5`	(Optional) Specifies the experimental field value in the header for an echo request packet of an IP SLAs operation. **Note** The LSP ping configuration mode is used in this example and in the remaining steps. Except where noted, the same commands are also supported in the LSP trace configuration mode.
Step 6	**request-data-size** *bytes*	(Optional) Specifies the protocol data size for a request packet of an IP SLAs operation.

	Command or Action	Purpose
	Example: `Router(config-sla-monitor-lspPing)# request-data-size 200`	
Step 7	**secondary-frequency** {**connection-loss** | **timeout**} *frequency* **Example:** `Router(config-sla-monitor-lspPing)# secondary-frequency connection-loss 10`	(Optional) Sets the faster measurement frequency (secondary frequency) to which an IP SLAs operation should change when a reaction condition occurs. • This command is for IP SLAs LSP ping operations only. LSP trace configuration mode does not support this command.
Step 8	**tag** *text* **Example:** `Router(config-sla-monitor-lspPing)# tag testgroup`	(Optional) Creates a user-specified identifier for an IP SLAs operation.
Step 9	**threshold** *milliseconds* **Example:** `Router(config-sla-monitor-lspPing)# threshold 6000`	(Optional) Sets the upper threshold value for calculating network monitoring statistics created by an IP SLAs operation.
Step 10	**timeout** *milliseconds* **Example:** `Router(config-sla-monitor-lspPing)# timeout 7000`	(Optional) Specifies the amount of time the IP SLAs operation waits for a response from its request packet.
Step 11	**ttl** *time-to-live* **Example:** `Router(config-sla-monitor-lspPing)# ttl 200`	(Optional) Specifies the maximum hop count for an echo request packet of an IP SLAs operation.
Step 12	**exit** **Example:** `Router(config-sla-monitor-lspPing)# exit`	Exits LSP ping or LSP trace configuration submode and returns to global configuration mode.
Step 13	**ip sla reaction-configuration** *operation-number* [**react** *monitored-element*] [**threshold-type** {**never** | **immediate** | **consecutive** [*consecutive-occurrences*] | **xofy** [*x-value y-value*] | **average** [*number-of-probes*]}] [**threshold-value** *upper-threshold lower-threshold*] [**action-type** {**none** | **trapOnly** | **triggerOnly** | **trapAndTrigger**}] **Example:** `Router(config)# ip sla reaction-configuration 1`	(Optional) Configures certain actions to occur based on events under the control of IP SLAs.

	Command or Action	Purpose
	`react connectionLoss threshold-type consecutive 3 action-type traponly`	
Step 14	**ip sla logging traps** **Example:** `Router(config)# ip sla logging traps`	(Optional) Enables the generation of SNMP system logging messages specific to IP SLAs trap notifications.
Step 15	**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:** `Router(config)# ip sla schedule 1 start-time now`	Configures the scheduling parameters for an IP SLAs operation.
Step 16	**exit** **Example:** `Router(config)# exit`	Exits global configuration submode and returns to privileged EXEC mode.

- Troubleshooting Tips, page 65
- What to Do Next, page 62

Troubleshooting Tips

Use the **debug ip sla trace** and **debug ip sla error** commands to help troubleshoot issues with an individual IP SLAs LSP ping or LSP traceroute operation.

What to Do Next

To display the results of an individual IP SLAs operation use the **show ip sla statistics** and **show ip sla statistics aggregated** commands. Checking the output for fields that correspond to criteria in your service level agreement will help you determine whether the service metrics are acceptable.

Verifying and Troubleshooting LSP Health Monitor Operations

SUMMARY STEPS

1. **debug ip sla error** [*operation-number*]
2. **debug ip sla mpls-lsp-monitor** [*operation-number*]
3. **debug ip sla trace** [*operation-number*]
4. **show ip sla mpls-lsp-monitor collection-statistics** [*group-id*]
5. **show ip sla mpls-lsp-monitor configuration** [*operation-number*]
6. **show ip sla mpls-lsp-monitor lpd operational-state** [*group-id*]
7. **show ip sla mpls-lsp-monitor neighbors**
8. **show ip sla mpls-lsp-monitor scan-queue** *operation-number*
9. **show ip sla mpls-lsp-monitor summary** [*operation-number* [**group** [*group-id*]]]
10. **show ip sla statistics** [*operation-number*] [**details**]
11. **show ip sla statistics aggregated** [*operation-number*] [**details**]
12. **show mpls discovery vpn**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**debug ip sla error** [*operation-number*] **Example:** `Router# debug ip sla error`	(Optional) Enables debugging output of IP SLAs operation run-time errors.
Step 2	**debug ip sla mpls-lsp-monitor** [*operation-number*] **Example:** `Router# debug ip sla mpls-lsp-monitor`	(Optional) Enables debugging output of LSP Health Monitor operations.
Step 3	**debug ip sla trace** [*operation-number*] **Example:** `Router# debug ip sla trace`	(Optional) Enables debugging output for tracing the execution of IP SLAs operations.
Step 4	**show ip sla mpls-lsp-monitor collection-statistics** [*group-id*] **Example:** `Router# show ip sla mpls-lsp-monitor collection-statistics 100001`	(Optional) Displays the statistics for IP SLAs operations belonging to an LSP discovery group of an LSP Health Monitor operation. **Note**This command is applicable only if the LSP discovery option is enabled.
Step 5	**show ip sla mpls-lsp-monitor configuration** [*operation-number*] **Example:** `Router# show ip sla mpls-lsp-monitor configuration 1`	(Optional) Displays configuration settings for LSP Health Monitor operations.

	Command or Action	Purpose
Step 6	**show ip sla mpls-lsp-monitor lpd operational-state** [*group-id*] **Example:** `Router# show ip sla mpls-lsp-monitor lpd operational-state 100001`	(Optional) Displays the operational status of the LSP discovery groups belonging to an LSP Health Monitor operation. **Note** This command is applicable only if the LSP discovery option is enabled.
Step 7	**show ip sla mpls-lsp-monitor neighbors** **Example:** `Router# show ip sla mpls-lsp-monitor neighbors`	(Optional) Displays routing and connectivity information about MPLS VPN BGP next hop neighbors discovered by the LSP Health Monitor operation.
Step 8	**show ip sla mpls-lsp-monitor scan-queue** *operation-number* **Example:** `Router# show ip sla mpls-lsp-monitor scan-queue 1`	(Optional) Displays information about adding or deleting BGP next hop neighbors from a particular MPLS VPN of an LSP Health Monitor operation.
Step 9	**show ip sla mpls-lsp-monitor summary** [*operation-number* [**group** [*group-id*]]] **Example:** `Router# show ip sla mpls-lsp-monitor summary`	(Optional) Displays BGP next hop neighbor and LSP discovery group information for LSP Health Monitor operations. **Note** This command is applicable only if the LSP discovery option is enabled.
Step 10	**show ip sla statistics** [*operation-number*] [**details**] **Example:** `Router# show ip sla statistics 100001`	(Optional) Displays the current operational status and statistics of all IP SLAs operations or a specified operation. **Note** This command applies only to manually configured IP SLAs operations.
Step 11	**show ip sla statistics aggregated** [*operation-number*] [**details**] **Example:** `Router# show ip sla statistics aggregated 100001`	(Optional) Displays the aggregated statistical errors and distribution information for all IP SLAs operations or a specified operation. **Note** This command applies only to manually configured IP SLAs operations.
Step 12	**show mpls discovery vpn** **Example:** `Router# show mpls discovery vpn`	(Optional) Displays routing information relating to the MPLS VPN BGP next hop neighbor discovery process.

Configuration Examples for LSP Health Monitors

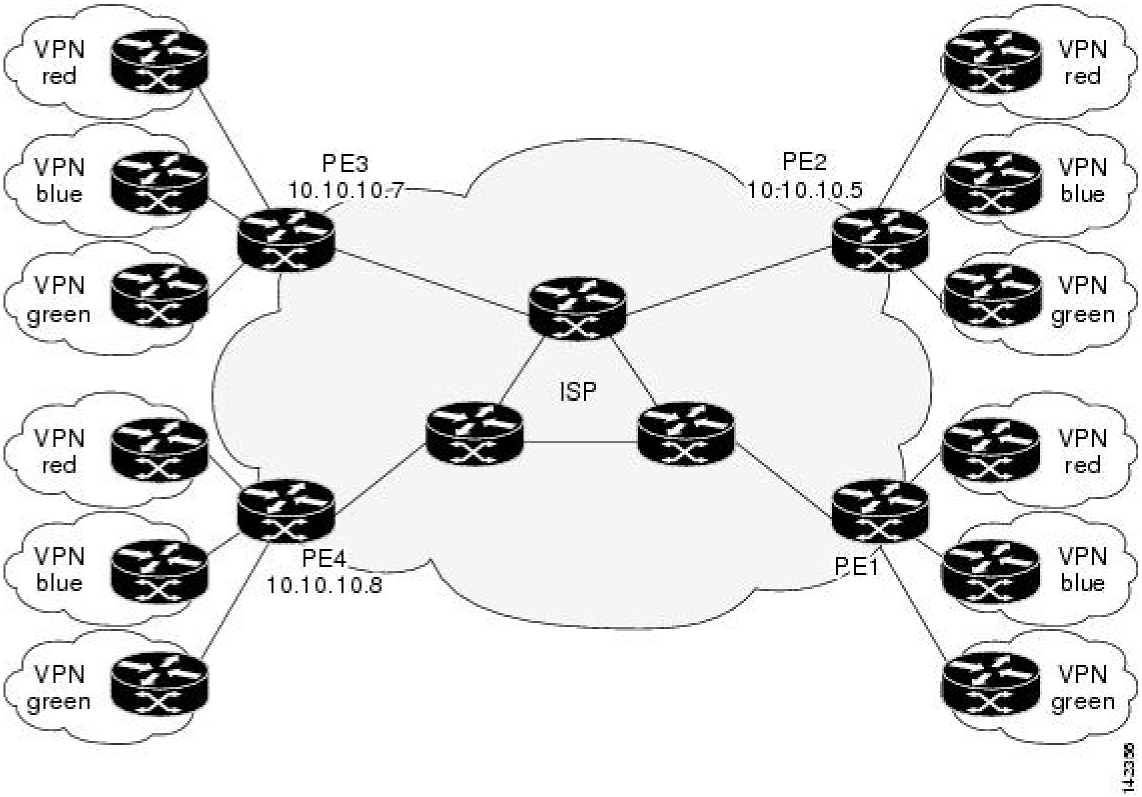
- Example Configuring and Verifying the LSP Health Monitor Without LSP Discovery, page 68
- Example Configuring and Verifying the LSP Health Monitor with LSP Discovery, page 71

- Example Manually Configuring an IP SLAs LSP Ping Operation, page 74

Example Configuring and Verifying the LSP Health Monitor Without LSP Discovery

The figure below illustrates a simple VPN scenario for an ISP. This network consists of a core MPLS VPN with four PE routers belonging to three VPNs: red, blue, and green. From the perspective of router PE1, these VPNs are reachable remotely through BGP next hop routers PE2 (router ID: 10.10.10.5), PE3 (router ID: 10.10.10.7), and PE4 (router ID: 10.10.10.8).

Figure 7: Network Used for LSP Health Monitor Example



The following example shows how to configure operation parameters, proactive threshold monitoring, and scheduling options on router PE1 (see the figure above) using the LSP Health Monitor. In this example, the LSP discovery option is enabled for LSP Health Monitor operation 1. Operation 1 is configured to automatically create IP SLAs LSP ping operations for all BGP next hop neighbors (PE2, PE3, and PE4) in use by all VRFs (red, blue, and green) associated with router PE1. The BGP next hop neighbor process is enabled, and the time interval at which routing entries that are no longer valid are removed from the BGP next hop neighbor discovery database is set to 60 seconds. The time interval at which the LSP Health Monitor checks the scan queue for BGP next hop neighbor updates is set to 1 minute. The secondary frequency option is enabled for both connection loss and timeout events, and the secondary frequency is set to 10 seconds. As specified by the proactive threshold monitoring configuration, when three consecutive connection loss or timeout events occur, an SNMP trap notification is sent. Multioperation scheduling and the generation of IP SLAs SNMP system logging messages are enabled.

Router PE1 Configuration

```
mpls discovery vpn interval 60
mpls discovery vpn next-hop
!
auto ip sla mpls-lsp-monitor 1
 type echo ipsla-vrf-all
 timeout 1000
 scan-interval 1
 secondary-frequency both 10
!
auto ip sla mpls-lsp-monitor reaction-configuration 1 react connectionLoss threshold-type
consecutive 3 action-type trapOnly
auto ip sla mpls-lsp-monitor reaction-configuration 1 react timeout threshold-type
consecutive 3 action-type trapOnly
ip sla traps
snmp-server enable traps rtr
!
auto ip sla mpls-lsp-monitor schedule 1 schedule-period 60 start-time now
```

The following is sample output from the **show ip sla mpls-lsp-monitor configuration** command for router PE1:

```
PE1# show ip sla mpls-lsp-monitor configuration 1
Entry Number : 1
Modification time   : *12:18:21.830 PDT Fri Aug 19 2005
Operation Type      : echo
Vrf Name            : ipsla-vrf-all
Tag                 :
EXP Value           : 0
Timeout(ms)         : 1000
Threshold(ms)       : 5000
Frequency(sec)      : Equals schedule period
LSP Selector        : 127.0.0.1
ScanInterval(min)   : 1
Delete Scan Factor  : 1
Operations List     : 100001-100003
Schedule Period(sec): 60
Request size        : 100
Start Time          : Start Time already passed
SNMP RowStatus      : Active
TTL value           : 255
Reply Mode          : ipv4
Reply Dscp Bits     :
Secondary Frequency : Enabled on Timeout
          Value(sec) : 10
Reaction Configs    :
    Reaction        : connectionLoss
    Threshold Type  : Consecutive
    Threshold Count : 3
    Action Type     : Trap Only
    Reaction        : timeout
    Threshold Type  : Consecutive
    Threshold Count : 3
    Action Type     : Trap Only
```

The following is sample output from the **show mpls discovery vpn** command for router PE1:

```
PE1# show mpls discovery vpn
Refresh interval set to 60 seconds.
Next refresh in 46 seconds
Next hop 10.10.10.5 (Prefix: 10.10.10.5/32)
        in use by: red, blue, green
Next hop 10.10.10.7 (Prefix: 10.10.10.7/32)
        in use by: red, blue, green
Next hop 10.10.10.8 (Prefix: 10.10.10.8/32)
        in use by: red, blue, green
```

The following is sample output from the **show ip sla mpls-lsp-monitor neighbors** command for router PE1:

```
PE1# show ip sla mpls-lsp-monitor neighbors
IP SLA MPLS LSP Monitor Database : 1
BGP Next hop 10.10.10.5 (Prefix: 10.10.10.5/32)  OK
  ProbeID: 100001 (red, blue, green)
BGP Next hop 10.10.10.7 (Prefix: 10.10.10.7/32)  OK
  ProbeID: 100002 (red, blue, green)
BGP Next hop 10.10.10.8 (Prefix: 10.10.10.8/32)  OK
  ProbeID: 100003 (red, blue, green)
```

The following is sample output from the **show ip sla mpls-lsp-monitor scan-queue 1** and **debug ip sla mpls-lsp-monitor** commands when IP connectivity from router PE1 to router PE4 is lost. This output shows that connection loss to each of the VPNs associated with router PE4 (red, blue, and green) was detected and that this information was added to the LSP Health Monitor scan queue. Also, since router PE4 is no longer a valid BGP next hop neighbor, the IP SLAs operation for router PE4 (Probe 10003) is being deleted.

```
PE1# show ip sla mpls-lsp-monitor scan-queue 1
Next scan Time after: 20 Secs
Next Delete scan Time after: 20 Secs
BGP Next hop    Prefix             vrf                              Add/Delete?
10.10.10.8      0.0.0.0/0          red                              Del(100003)
10.10.10.8      0.0.0.0/0          blue                             Del(100003)
10.10.10.8      0.0.0.0/0          green                            Del(100003)
PE1# debug ip sla mpls-lsp-monitor
IP SLAs MPLSLM debugging for all entries is on
*Aug 19 19:48: IP SLAs MPLSLM(1):Next hop 10.10.10.8 added in DeleteQ(1)
*Aug 19 19:49: IP SLAs MPLSLM(1):Removing vrf red from tree entry 10.10.10.8
*Aug 19 19:56: IP SLAs MPLSLM(1):Next hop 10.10.10.8 added in DeleteQ(1)
*Aug 19 19:56: IP SLAs MPLSLM(1):Next hop 10.10.10.8 added in DeleteQ(1)
*Aug 19 19:49: IP SLAs MPLSLM(1):Removing vrf blue from tree entry 10.10.10.8
*Aug 19 19:49: IP SLAs MPLSLM(1):Removing vrf green from tree entry 10.10.10.8
*Aug 19 19:49: IP SLAs MPLSLM(1):Removing Probe 100003
```

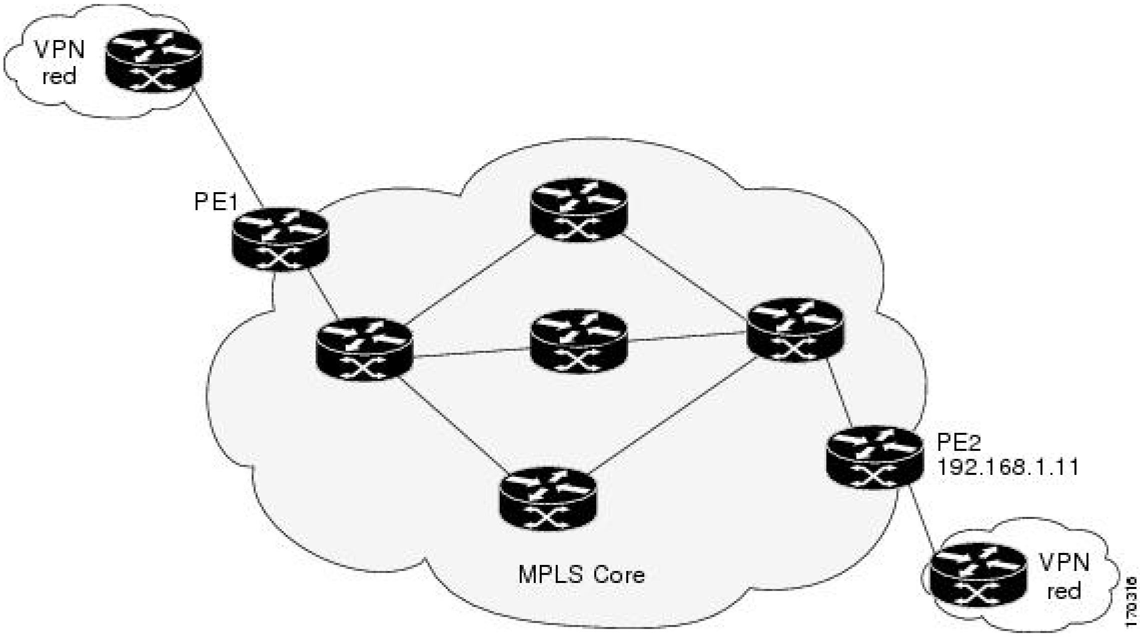
The following is sample output from the **show ip sla mpls-lsp-monitor scan-queue 1** and **debug ip sla mpls-lsp-monitor** commands when IP connectivity from router PE1 to router PE4 is restored. This output shows that each of the VPNs associated with router PE4 (red, blue, and green) were discovered and that this information was added to the LSP Health Monitor scan queue. Also, since router PE4 is a newly discovered BGP next hop neighbor, a new IP SLAs operation for router PE4 (Probe 100005) is being created and added to the LSP Health Monitor multioperation schedule. Even though router PE4 belongs to three VPNs, only one IP SLAs operation is being created.

```
PE1# show ip sla mpls-lsp-monitor scan-queue 1
Next scan Time after: 23 Secs
Next Delete scan Time after: 23 Secs
BGP Next hop    Prefix             vrf                              Add/Delete?
10.10.10.8      10.10.10.8/32      red                              Add
10.10.10.8      10.10.10.8/32      blue                             Add
10.10.10.8      10.10.10.8/32      green                            Add
PE1# debug ip sla mpls-lsp-monitor
IP SLAs MPLSLM debugging for all entries is on
*Aug 19 19:59: IP SLAs MPLSLM(1):Next hop 10.10.10.8 added in AddQ
*Aug 19 19:59: IP SLAs MPLSLM(1):Next hop 10.10.10.8 added in AddQ
*Aug 19 19:59: IP SLAs MPLSLM(1):Next hop 10.10.10.8 added in AddQ
*Aug 19 19:59: IP SLAs MPLSLM(1):Adding vrf red into tree entry 10.10.10.8
*Aug 19 19:59: IP SLAs MPLSLM(1):Adding Probe 100005
*Aug 19 19:59: IP SLAs MPLSLM(1):Adding ProbeID 100005 to tree entry 10.10.10.8 (1)
*Aug 19 19:59: IP SLAs MPLSLM(1):Adding vrf blue into tree entry 10.10.10.8
*Aug 19 19:59: IP SLAs MPLSLM(1):Duplicate in AddQ 10.10.10.8
*Aug 19 19:59: IP SLAs MPLSLM(1):Adding vrf green into tree entry 10.10.10.8
*Aug 19 19:59: IP SLAs MPLSLM(1):Duplicate in AddQ 10.10.10.8
*Aug 19 19:59: IP SLAs MPLSLM(1):Added Probe(s) 100005 will be scheduled after 26 secs
over schedule period 60
```

Example Configuring and Verifying the LSP Health Monitor with LSP Discovery

The figure below illustrates a simple VPN scenario for an ISP. This network consists of a core MPLS VPN with two PE routers belonging to a VPN named red. From the perspective of router PE1, there are three equal-cost multipaths available to reach router PE2.

Figure 8: Network Used for LSP Health Monitor with LSP Discovery Example



The following example shows how to configure operation parameters, proactive threshold monitoring, and scheduling options on router PE1 (see the figure above) using the LSP Health Monitor. In this example, the LSP discovery option is enabled for LSP Health Monitor operation 100. Operation 100 is configured to automatically create IP SLAs LSP ping operations for all equal-cost multipaths between router PE1 and router PE2. The BGP next hop neighbor process is enabled, and the time interval at which routing entries that are no longer valid are removed from the BGP next hop neighbor discovery database is set to 30 seconds. The time interval at which the LSP Health Monitor checks the scan queue for BGP next hop neighbor updates is set to 1 minute. The secondary frequency option is enabled for both connection loss and timeout events, and the secondary frequency is set to 5 seconds. The explicit null label option for echo request packets is enabled. The LSP rediscovery time period is set to 3 minutes. As specified by the proactive threshold monitoring configuration, an SNMP trap notification will be sent when an LSP discovery group status changes occurs. Multioperation scheduling and the generation of IP SLAs SNMP system logging messages are enabled.

Router PE1 Configuration

```
mpls discovery vpn next-hop
mpls discovery vpn interval 30
!
auto ip sla mpls-lsp-monitor 100
 type echo ipsla-vrf-all
 scan-interval 1
 secondary-frequency both 5
!
 path-discover
 force-explicit-null
 scan-period 3
!
auto ip sla mpls-lsp-monitor reaction-configuration 100 react lpd-group retry 3 action-
type trapOnly
!
auto ip sla mpls-lsp-monitor schedule 100 schedule-period 30 start-time now
!
ip sla logging traps
snmp-server enable traps rtr
```

The following is sample output from the **show ip sla mpls-lsp-monitor configuration** command for router PE1:

```
PE1# show ip sla mpls-lsp-monitor configuration
Entry Number : 100
Modification time   : *21:50:16.411 GMT Tue Jun 20 2006
Operation Type      : echo
Vrf Name            : ipsla-vrf-all
Tag                 :
EXP Value           : 0
Timeout(ms)         : 5000
Threshold(ms)       : 50
Frequency(sec)      : Equals schedule period
ScanInterval(min)   : 1
Delete Scan Factor  : 1
Operations List     : 100002
Schedule Period(sec): 30
Request size        : 100
Start Time          : Start Time already passed
SNMP RowStatus      : Active
TTL value           : 255
Reply Mode          : ipv4
Reply Dscp Bits     :
Path Discover       : Enable
    Maximum sessions          : 1
    Session Timeout(seconds)  : 120
    Base LSP Selector         : 127.0.0.0
    Echo Timeout(seconds)     : 5
    Send Interval(msec)       : 0
    Label Shimming Mode       : force-explicit-null
    Number of Stats Hours     : 2
    Scan Period(minutes)      : 3
Secondary Frequency : Enabled on Connection Loss and Timeout
         Value(sec) : 5
Reaction Configs    :
    Reaction        : Lpd Group
    Retry Number    : 3
    Action Type     : Trap Only
```

The following is sample output from the **show mpls discovery vpn** command for router PE1:

```
PE1# show mpls discovery vpn
Refresh interval set to 30 seconds.
Next refresh in 4 seconds
Next hop 192.168.1.11 (Prefix: 192.168.1.11/32)
        in use by: red
```

The following is sample output from the **show ip sla mpls-lsp-monitor neighbors** command for router PE1:

```
PE1# show ip sla mpls-lsp-monitor neighbors
IP SLA MPLS LSP Monitor Database : 100
BGP Next hop 192.168.1.11 (Prefix: 192.168.1.11/32)  OK Paths: 3
  ProbeID: 100001 (red)
```

The following is sample output from the **show ip sla mpls-lsp-monitor lpd operational-state** command for LSP discovery group 100001:

```
PE1# show ip sla mpls-lsp-monitor lpd operational-state
Entry number: 100001
MPLSLM Entry Number: 100
Target FEC Type: LDP IPv4 prefix
Target Address: 192.168.1.11
Number of Statistic Hours Kept: 2
Last time LPD Stats were reset: *21:21:18.239 GMT Tue Jun 20 2006
Traps Type: 3
Latest Path Discovery Mode: rediscovery complete
Latest Path Discovery Start Time: *21:59:04.475 GMT Tue Jun 20 2006
Latest Path Discovery Return Code: OK
Latest Path Discovery Completion Time(ms): 3092
Number of Paths Discovered: 3
Path Information :
Path   Outgoing   Lsp             Link  Conn  Adj             Downstream
Index  Interface  Selector        Type  Id    Addr            Label Stack     Status
1      Et0/0      127.0.0.8       90    0     10.10.18.30     21              OK
2      Et0/0      127.0.0.2       90    0     10.10.18.30     21              OK
3      Et0/0      127.0.0.1       90    0     10.10.18.30     21              OK
```

The following is sample output from the **show ip sla mpls-lsp-monitor collection-statistics** command for LSP discovery group 100001:

```
PE1# show ip sla mpls-lsp-monitor collection-statistics
Entry number: 100001
Start Time Index: *21:52:59.795 GMT Tue Jun 20 2006
Path Discovery Start Time: *22:08:04.507 GMT Tue Jun 20 2006
Target Destination IP address: 192.168.1.11
Path Discovery Status: OK
Path Discovery Completion Time: 3052
Path Discovery Minimum Paths: 3
Path Discovery Maximum Paths: 3
LSP Group Index: 100002
LSP Group Status: up
Total Pass: 36
Total Timeout: 0        Total Fail: 0
Latest Probe Status: 'up,up,up'
Latest Path Identifier: '127.0.0.8-Et0/0-21,127.0.0.2-Et0/0-21,127.0.0.1-Et0/0-21'
Minimum RTT: 280        Maximum RTT: 324        Average RTT: 290
```

The following is sample output from the **show ip sla mpls-lsp-monitor summary** command for LSP Health Monitor operation 100:

```
PE1# show ip sla mpls-lsp-monitor summary 100
Index                    -  MPLS LSP Monitor probe index
Destination              -  Target IP address of the BGP next hop
Status                   -  LPD group status
LPD Group ID             -  Unique index to identify the LPD group
Last Operation Time      -  Last time an operation was attempted by
                            a particular probe in the LPD Group
Index  Destination     Status     LPD Group ID    Last Operation Time
100    192.168.1.11    up         100001          *22:20:29.471 GMT Tue Jun 20 2006
```

The following is sample output from the **show ip sla mpls-lsp-monitor summary** command for LSP discovery group 100001:

```
PE1#show ip sla mpls-lsp-monitor summary 100 group 100001
Group ID                 -  unique number to identify a LPD group
Lsp-selector             -  Unique 127/8 address used to identify a LPD
Last Operation status    -  Latest probe status
Last RTT                 -  Latest Round Trip Time
Last Operation Time      -  Time when the last operation was attempted
Group ID  Lsp-Selector    Status     Failures    Successes   RTT   Last Operation Time
100001    127.0.0.8       up         0           55          320   *22:20:29.471 GMT Tue
Jun 20 2006
100001    127.0.0.2       up         0           55          376   *22:20:29.851 GMT Tue
```

```
Jun 20 2006
100001    127.0.0.1       up         0           55          300    *22:20:30.531 GMT Tue
Jun 20 2006
```

Example Manually Configuring an IP SLAs LSP Ping Operation

The following example shows how to manually configure and schedule an IP SLAs LSP ping operation:

```
ip sla 1
mpls lsp ping ipv4 192.168.1.4 255.255.255.255 lsp-selector 127.1.1.1
frequency 120
secondary-frequency timeout 30
!
ip sla reaction-configuration 1 react connectionLoss threshold-type consecutive 3 action-
type trapOnly
ip sla reaction-configuration 1 react timeout threshold-type consecutive 3 action-type
trapOnly
ip sla logging traps
!
ip sla schedule 1 start-time now life forever
```

Additional References

Related Documents

Related Topic	Document Title
MPLS LSP discovery management tool	MPLS EM-MPLS LSP Multipath Tree Trace chapter of the *Cisco IOS XE Multiprotocol Label Switching Configuration Guide*
Configuring standard IP access lists	Access Control Lists chapter of the *Cisco IOS XE Security Configuration Guide: Securing the Data Plane*
Multioperation scheduling for IP SLAs	Configuring Multioperation Scheduling of IP SLAs Operations chapter of the *Cisco IOS XE IP SLAs Configuration Guide*
Proactive threshold monitoring for IP SLAs	Configuring Proactive Threshold Monitoring of IP SLAs Operations chapter of the *Cisco IOS XE IP SLAs Configuration Guide*
Cisco IOS commands	Cisco IOS Master Commands List, All Releases
Cisco IOS IP SLAs commands	*Cisco IOS IP SLAs Command Reference*

Standards

Standard	Title
draft-ietf-mpls-lsp-ping-09.txt	Detecting MPLS Data Plane Failures

Standard	Title
draft-ietf-mpls-oam-frmwk-03.txt	A Framework for MPLS Operations and Management (OAM)
draft-ietf-mpls-oam-requirements-06.txt	OAM Requirements for MPLS Networks

MIBs

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

RFCs

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

Technical Assistance

Description	Link
The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.	http://www.cisco.com/cisco/web/support/index.html

Feature Information for LSP Health Monitor Operations

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 http://www.cisco.com/go/cfn. An account on Cisco.com is not required.

Table 12: Feature Information for the LSP Health Monitor

Feature Name	Releases	Feature Information
IP SLAs--LSP Health Monitor	Cisco IOS XE Release 2.2	The IP SLAs LSP Health Monitor feature provides the capability to proactively monitor Layer 3 MPLS VPNs.
IP SLAs--LSP Health Monitor with LSP Discovery	Cisco IOS XE Release 2.2	The LSP discovery capability was added.

Any Internet Protocol (IP) addresses and phone numbers used in this document are not intended to be actual addresses and phone numbers. Any examples, command display output, network topology diagrams, and other figures included in the document are shown for illustrative purposes only. Any use of actual IP addresses or phone numbers in illustrative content is unintentional and coincidental.

Configuring IP SLAs for Metro-Ethernet

This module describes how to configure an IP Service Level Agreements (SLAs) for Metro-Ethernet to gather network performance metrics in service-provider Ethernet networks. Available statistical measurements for the IP SLAs Ethernet operation include round-trip time, jitter (interpacket delay variance), and packet loss.

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest feature information and caveats, see the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the Feature Information Table at the end of this document.

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

Prerequisites for IP SLAs for Metro-Ethernet

It is recommended that the IEEE 802.1ag standard is supported on the destination devices in order to obtain complete error reporting and diagnostics information.

Restrictions for IP SLAs for Metro-Ethernet

Memory and performance may be impacted for a given Ethernet CFM maintenance domain and Ethernet Virtual Circuit (EVC) or VLAN that has a large number of maintenance endpoints (MEPs).

Information About IP SLAs for Metro-Ethernet

IP SLAs Ethernet Operation Basics

The IP SLAs for Metro-Ethernet integrates IP SLAs with the Ethernet Connectivity Fault Management (CFM) feature. Ethernet CFM is an end-to-end per-service-instance Ethernet-layer operation, administration, and management (OAM) protocol.

The IP SLAs for Metro-Ethernet feature provides the capability to gather statistical measurements by sending and receiving Ethernet data frames between Ethernet CFM maintenance endpoints (MEPs). The performance metrics for IP SLAs Ethernet operations are measured between a source MEP and a destination MEP. Unlike existing IP SLAs operations that provide performance metrics for the IP layer, the IP SLAs Ethernet operation provides performance metrics for Layer 2.

IP SLAs Ethernet operations may be configured using the command-line interface (CLI) or Simple Network Management Protocol (SNMP).

You can manually configure individual Ethernet ping or Ethernet jitter operations by specifying the destination MEP identification number, name of the maintenance domain, and EVC or VLAN identifier or port level option.

You also have the option to configure an IP SLAs auto Ethernet operation (ping or jitter) that will query the Ethernet CFM database for all maintenance endpoints in a given maintenance domain and EVC or VLAN. When an IP SLAs auto Ethernet operation is configured, individual Ethernet ping or Ethernet jitter operations are automatically created based on the MEPs that were discovered. A notification mechanism exists between the IP SLAs and Ethernet CFM subsystems to facilitate the automatic creation of Ethernet ping or Ethernet jitter operations for applicable MEPs that are added to a given maintenance domain and EVC or VLAN while an auto Ethernet operation is running.

The IP SLAs for Metro-Ethernet feature supports multioperation scheduling of IP SLAs operations and proactive threshold violation monitoring through SNMP trap notifications and syslog messages.

Statistics Measured by the IP SLAs Ethernet Operation

The network performance metrics supported by the IP SLAs Ethernet operation is similar to the metrics supported by existing IP SLAs operations. The statistical measurements supported by the IP SLAs Ethernet jitter operation include the following:

- Jitter (source-to-destination and destination-to-source)
- Round-trip time latency
- Unprocessed packets
- Packet loss (source-to-destination and destination-to-source)
- Out-of-sequence, tail-dropped, and late packets

How to Configure IP SLAs for Metro-Ethernet

Note There is no need to configure an IP SLAs responder on the destination device.

- Configuring an IP SLAs Auto Ethernet Operation with Endpoint Discovery on the Source Device, page 79
- Manually Configuring an IP SLAs Ethernet Ping or Jitter Operation on the Source Device, page 81
- Scheduling IP SLAs Operations, page 84

Configuring an IP SLAs Auto Ethernet Operation with Endpoint Discovery on the Source Device

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip sla ethernet-monitor** *operation-number*
4. **type echo domain** *domain-name* {**evc** *evc-id* | **vlan** *vlan-id*} [**exclude-mpids** *mp-ids*]
5. **type jitter domain** *domain-name* {**evc** *evc-id* | **vlan** *vlan-id*} [**exclude-mpids** *mp-ids*] [**interval** *interframe-interval*] [**num-frames** *frames-number*]
6. **cos** *cos-value*
7. **owner** *owner-id*
8. **request-data-size** *bytes*
9. **tag** *text*
10. **threshold** *milliseconds*
11. **timeout** *milliseconds*
12. **end**
13. **show ip sla ethernet-monitor configuration** [*operation-number*]

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**ip sla ethernet-monitor** *operation-number*	Begins configuration for an IP SLAs auto Ethernet operation and enters IP SLA Ethernet monitor configuration mode.

	Command or Action	Purpose
	Example: `Router(config)# ip sla ethernet-monitor 1`	
Step 4	**type echo domain** *domain-name* {**evc** *evc-id* | **vlan** *vlan-id*} [**exclude-mpids** *mp-ids*] **Example:** `Router(config-ip-sla-ethernet-monitor)# type echo domain testdomain vlan 34`	For Echo operations only: Configures an auto Ethernet operation for Ethernet ping operations.
Step 5	**type jitter domain** *domain-name* {**evc** *evc-id* | **vlan** *vlan-id*} [**exclude-mpids** *mp-ids*] [**interval** *interframe-interval*] [**num-frames** *frames-number*] **Example:** `Router(config-ip-sla-ethernet-monitor)# type jitter domain testdomain evc testevc interval 20 num-frames 30`	For Jitter operations only: Configures an auto Ethernet operation for Ethernet jitter operations.
Step 6	**cos** *cos-value* **Example:** `Router(config-ip-sla-ethernet-params)# cos 2`	(Optional) Sets the class of service for an IP SLAs Ethernet operation.
Step 7	**owner** *owner-id* **Example:** `Router(config-ip-sla-ethernet-params)# owner admin`	(Optional) Configures the Simple Network Management Protocol (SNMP) owner of an IP SLAs operation.
Step 8	**request-data-size** *bytes* **Example:** `Router(config-ip-sla-ethernet-params)# request-data-size 64`	(Optional) Sets the padding size for the data frame of an IP SLAs Ethernet operation. • The default value for IP SLAs Ethernet ping operations is 66 bytes. • The default value for IP SLAs Ethernet jitter operations is 51 bytes.
Step 9	**tag** *text* **Example:** `Router(config-ip-sla-ethernet-params)# tag TelnetPollSever1`	(Optional) Creates a user-specified identifier for an IP SLAs operation.
Step 10	**threshold** *milliseconds*	(Optional) Sets the upper threshold value for calculating network monitoring statistics created by an IP SLAs operation.

	Command or Action	Purpose
	Example: `Router(config-ip-sla-ethernet-params)# threshold 10000`	
Step 11	**timeout** *milliseconds* **Example:** `Router(config-ip-sla-ethernet-params)# timeout 10000`	(Optional) Sets the amount of time an IP SLAs operation waits for a response from its request packet.

Step 12	**end**
	Example:
	`Router(config-ip-sla-ethernet-params)# end`
		Exits to privileged EXEC configuration mode.

Step 13	**show ip sla ethernet-monitor configuration** [*operation-number*] **Example:** `Router# show ip sla ethernet-monitor configuration 1`	(Optional) Displays configuration settings for all IP SLAs auto Ethernet operations or a specified auto Ethernet operation.

Manually Configuring an IP SLAs Ethernet Ping or Jitter Operation on the Source Device

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip sla** *operation-number*
4. **ethernet echo mpid** *mp-id* **domain** *domain-name* {**evc** *evc-id* | **port** | **vlan** *vlan-id*}
5. **ethernet jitter mpid** *mp-id* **domain** *domain-name* {**evc** *evc-id* | **port** | **vlan** *vlan-id*} [**interval** *interframe-interval*] [**num-frames** *frames-number*]
6. **cos** *cos-value*
7. **frequency** *seconds*
8. **history** *history-parameter*
9. **owner** *owner-id*
10. **request-data-size** *bytes*
11. **tag** *text*
12. **threshold** *milliseconds*
13. **timeout** *milliseconds*
14. **end**
15. **show ip sla configuration** [*operation-number*]
16. **show ip sla application**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**ip sla** *operation-number* **Example:** `Router(config)# ip sla 1`	Begins configuration for an IP SLAs operation and enters IP SLA configuration mode.

Step 4	**ethernet echo mpid** *mp-id* **domain** *domain-name* {**evc** *evc-id* | **port** | **vlan** *vlan-id*}
	Example:
	`Router(config-ip-sla)# ethernet echo mpid 23 domain testdomain vlan 34`
		For a ping operation only:
		Configures the IP SLAs operation as an Ethernet ping operation and enters Ethernet echo configuration mode.

	Command or Action	Purpose
Step 5	**ethernet jitter mpid** *mp-id* **domain** *domain-name* {**evc** *evc-id* | **port** | **vlan** *vlan-id*} [**interval** *interframe-interval*] [**num-frames** *frames-number*] **Example:** `Router(config-ip-sla)# ethernet jitter mpid 23 domain testdomain evc testevc interval 20 num-frames 30`	For a jitter operation only: Configures the IP SLAs operation as an Ethernet jitter operation and enters Ethernet jitter configuration mode.
Step 6	**cos** *cos-value* **Example:** `Router(config-ip-sla-ethernet-echo)# cos 2`	(Optional) Sets the class of service for an IP SLAs Ethernet operation. **Note** For this and the remaining steps, the configuration mode shown in the example is for the Ethernet echo operation. However, the commands are the same in the Ethernet jitter configuration mode.
Step 7	**frequency** *seconds* **Example:** `Router(config-ip-sla-ethernet-echo)# frequency 30`	(Optional) Sets the rate at which a specified IP SLAs operation repeats.
Step 8	**history** *history-parameter* **Example:** `Router(config-ip-sla-ethernet-echo)# history hours-of-statistics-kept 3`	(Optional) Specifies the parameters used for gathering statistical history information for an IP SLAs operation.
Step 9	**owner** *owner-id* **Example:** `Router(config-ip-sla-ethernet-echo)# owner admin`	(Optional) Configures the Simple Network Management Protocol (SNMP) owner of an IP SLAs operation.
Step 10	**request-data-size** *bytes* **Example:** `Router(config-ip-sla-ethernet-echo)# request-data-size 64`	(Optional) Sets the padding size for the data frame of an IP SLAs Ethernet operation. The default value for IP SLAs Ethernet ping operations is 66 bytes. The default value for IP SLAs Ethernet jitter operations is 51 bytes.
Step 11	**tag** *text* **Example:** `Router(config-ip-sla-ethernet-echo)# tag TelnetPollSever1`	(Optional) Creates a user-specified identifier for an IP SLAs operation.
Step 12	**threshold** *milliseconds*	(Optional) Sets the upper threshold value for calculating network monitoring statistics created by an IP SLAs operation.

	Command or Action	Purpose
	Example: `Router(config-ip-sla-ethernet-echo)# threshold 10000`	
Step 13	**timeout** *milliseconds* **Example:** `Router(config-ip-sla-ethernet-echo)# timeout 10000`	(Optional) Sets the amount of time an IP SLAs operation waits for a response from its request packet.

Step 14	**end**
	Example:
	`Router(config-ip-sla-ethernet-echo)# end`
		Exits to privileged EXEC mode.

Step 15	**show ip sla configuration** [*operation-number*] **Example:** `Router# show ip sla configuration 1`	(Optional) Displays configuration values including all defaults for all IP SLAs operations or a specified operation.
Step 16	**show ip sla application** **Example:** `Router# show ip sla application`	(Optional) Displays global information about supported IP SLAs features.

Scheduling IP SLAs Operations

Note

- All IP SLAs operations to be scheduled must be already configured.
- The frequency of all operations scheduled in an operation group must be the same unless you are enabling the random scheduler option for a multioperation scheduler.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip sla ethernet-monitor schedule** *operation-number* **schedule-period** *seconds* [**frequency** [*seconds*]] [**start-time** {**after** *hh* **:** *mm* **:** *ss* | *hh* **:** *mm*[**:** *ss*] [*month day* | *day month*] | **now** | **pending**}]
4. **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**]
5. **ip sla group schedule** *group-operation-number operation-id-numbers* **schedule-period** *schedule-period-range* [**ageout** *seconds*] [**frequency** *group-operation-frequency*] [**life**{**forever** | *seconds*}] [**start-time**{*hh:mm*[*:ss*] [*month day* | *day month*] | **pending** | **now** | **after** *hh:mm:ss*}]
6. **exit**
7. **show ip sla group schedule**
8. **show ip sla configuration**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**ip sla ethernet-monitor schedule** *operation-number* **schedule-period** *seconds* [**frequency** [*seconds*]] [**start-time** {**after** *hh* **:** *mm* **:** *ss* | *hh* **:** *mm*[**:** *ss*] [*month day* | *day month*] | **now** | **pending**}] **Example:** `Router(config)# ip sla ethernet-monitor schedule 10 schedule-period 60 start-time now`	For individual auto Ethernet operations only: Configures scheduling parameters for an IP SLAs auto Ethernet operation.
Step 4	**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:** `Router(config)# ip sla schedule 1 start-time now life forever`	For individual IP SLAs operations only: Configures the scheduling parameters for an individual IP SLAs operation.
Step 5	**ip sla group schedule** *group-operation-number operation-id-numbers* **schedule-period** *schedule-period-range* [**ageout** *seconds*] [**frequency** *group-operation-frequency*] [**life**{**forever** | *seconds*}] [**start-**	For mulioperation scheduler only: Specifies an IP SLAs operation group number and the range of operation numbers

	Command or Action	Purpose
	time{*hh:mm*[:*ss*] [*month day* | *day month*] | **pending** | **now** | **after** *hh:mm:ss*}] **Example:** `Router(config)# ip sla group schedule 1 3,4,6-9`	to be scheduled in global configuration mode.
Step 6	**exit** **Example:** `Router(config)# exit`	Exits to the privileged EXEC mode.
Step 7	**show ip sla group schedule** **Example:** `Router# show ip sla group schedule`	(Optional) Displays the IP SLAs group schedule details.
Step 8	**show ip sla configuration** **Example:** `Router# show ip sla configuration`	(Optional) Displays the IP SLAs configuration details.

- Troubleshooting Tips, page 86
- What to Do Next, page 16

Troubleshooting Tips

Use the **debug ip sla trace** and **debug ip sla error** commands to help troubleshoot issues with an individual IP SLAs Ethernet ping or Ethernet jitter operation. Use the **debug ip sla ethernet-monitor** command to help troubleshoot issues with an IP SLAs auto Ethernet operation.

What to Do Next

To add proactive threshold conditions and reactive triggering for generating traps, or for starting another operation, to an IP SLAs operation, see the "Configuring Proactive Threshold Monitoring" section.

To view and interpret the results of an IP SLAs operation use the **show ip sla statistics** command. Checking the output for fields that correspond to criteria in your service level agreement will help you determine whether the service metrics are acceptable.

Configuration Examples for IP SLAs for Metro-Ethernet

- Example Configuring an IP SLAs Ethernet Operation with Endpoint Discovery, page 87
- Example Manually Configuring an Individual IP SLAs Ethernet Operation, page 87

Example Configuring an IP SLAs Ethernet Operation with Endpoint Discovery

The following examples show how to configure operation parameters, proactive threshold monitoring, and scheduling options using an IP SLAs auto Ethernet operation. In Configuration A, operation 10 is configured to automatically create IP SLAs Ethernet ping operations for all the discovered maintenance endpoints in the domain named testdomain and VLAN identification number 34. In Configuration B, operation 20 is configured to automatically create IP SLAs Ethernet ping operations for all the discovered maintenance endpoints in the domain named testdomain and VLAN identification number 36. In both configurations, the proactive threshold monitoring configuration specifies that when three consecutive connection loss events occur, an SNMP trap notification should be sent. The schedule period for operation 10 and operation 20 is 60 seconds, and both operations are scheduled to start immediately.

Configuration A

```
ip sla ethernet-monitor 10
 type echo domain testdomain vlan 34
!
ip sla ethernet-monitor reaction-configuration 10 react connectionLoss threshold-type
consecutive 3 action-type trapOnly
!
ip sla ethernet-monitor schedule 10 schedule-period 60 start-time now
```

Configuration B

```
ip sla ethernet-monitor 20
 type echo domain testdomain vlan 36
!
ip sla ethernet-monitor reaction-configuration 20 react connectionLoss threshold-type
consecutive 3 action-type trapOnly
!
ip sla ethernet-monitor schedule 20 schedule-period 60 start-time now
```

Example Manually Configuring an Individual IP SLAs Ethernet Operation

The following examples show how to configure an IP SLAs Ethernet ping operation. In Configuration C, the maintenance endpoint identification number is 23, the maintenance domain name is testdomain, and the VLAN identification number is 34. In Configuration D, the maintenance endpoint identification number is 23, the maintenance domain name is testdomain, and the VLAN identification number 36. In both configurations, the proactive threshold monitoring configuration specifies that when three consecutive connection loss events occur, an SNMP trap notification should be sent. Operation 1 and operation 5 are scheduled to start immediately.

Configuration C

```
ip sla 1
 ethernet echo mpid 23 domain testdomain vlan 34
!
ip sla reaction-configuration 1 react connectionLoss threshold-type consecutive 3 action-
type trapOnly
!
ip sla schedule 1 start-time now
```

Configuration D

```
ip sla 5
```

```
 ethernet echo mpid 23 domain testdomain vlan 36
!
ip sla reaction-configuration 5 react connectionLoss threshold-type consecutive 3 action-
type trapOnly
!
ip sla schedule 5 start-time now
```

Additional References

Related Documents

Related Topic	Document Title
Cisco IOS commands	Cisco IOS Master Commands List, All Releases
Cisco IOS IP SLAs commands	*Cisco IOS IP SLAs Command Reference*
Ethernet CFM	Configuring Ethernet Connectivity Fault Management module of the *Cisco IOS XE Carrier Ethernet Configuration Guide*
Multioperation scheduling for Cisco IOS IP SLAs	Configuring a Multiple Operation Scheduler module of the *Cisco IOS XE IP SLAs Configuration Guide*

Standards

Standard	Title
IEEE 802.1ag	*Connectivity Fault Management*

MIBs

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

RFCs

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

Technical Assistance

Description	Link
The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.	http://www.cisco.com/cisco/web/support/index.html

FeatureInformationforIPSLAsforMetro-Ethernet

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 http://www.cisco.com/go/cfn. An account on Cisco.com is not required.

Table 13: Feature Information for the IP SLAs Ethernet Operation

Feature Name	Releases	Feature Information
IP SLAs for Metro-Ethernet	Cisco IOS XE Release 2.1	The IP Service Level Agreements (SLAs) for Metro-Ethernet feature provides the capability to gather Ethernet-layer network performance metrics. Available statistical measurements for the IP SLAs Ethernet operation include round-trip time, jitter (interpacket delay variance), and packet loss.

Any Internet Protocol (IP) addresses and phone numbers used in this document are not intended to be actual addresses and phone numbers. Any examples, command display output, network topology diagrams, and other figures included in the document are shown for illustrative purposes only. Any use of actual IP addresses or phone numbers in illustrative content is unintentional and coincidental.

Configuring IP SLAs UDP Echo Operations

This module describes how to configure an IP Service Level Agreements (SLAs) User Datagram Protocol (UDP) Echo operation to monitor end-to-end response time between a Cisco router and devices using IPv4 or IPv6. UDP echo accuracy is enhanced by using the IP SLAs Responder at the destination Cisco router. This module also demonstrates how the results of the UDP echo operation can be displayed and analyzed to determine how a UDP application is performing.

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest feature information and caveats, see the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the Feature Information Table at the end of this document.

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

Restrictions for IP SLAs UDP Echo Operations

We recommend using a Cisco networking device as the destination device, although any networking device that supports RFC 862, *Echo Protocol* , can be used.

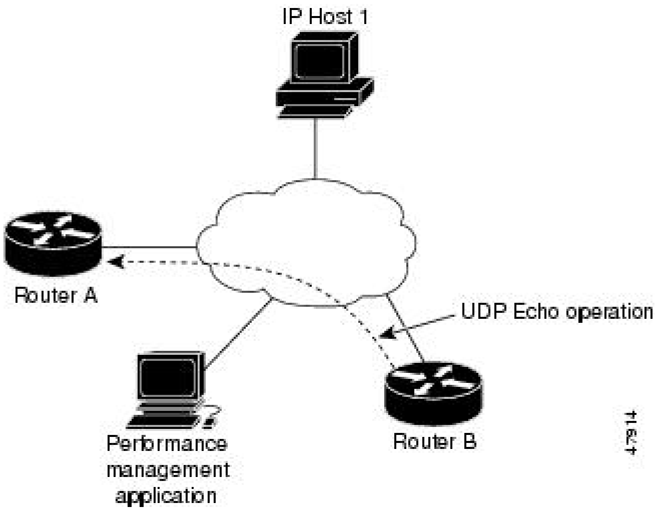
Information About IP SLAs UDP Echo Operations

UDP Echo Operation

The UDP echo operation measures end-to-end response time between a Cisco router and devices using IP. UDP is a transport layer (Layer 4) Internet protocol that is used for many IP services. UDP echo is used to measure response times and test end-to-end connectivity.

In the figure below Router A has been configured as an IP SLAs Responder and Router B is configured as the source IP SLAs device.

Figure 9: UDP Echo Operation



Response time (round-trip time) is computed by measuring the time taken between sending a UDP echo request message from Router B to the destination router--Router A--and receiving a UDP echo reply from Router A. UDP echo accuracy is enhanced by using the IP SLAs Responder at Router A, the destination Cisco router. If the destination router is a Cisco router, then IP SLAs sends a UDP datagram to any port number that you specified. Using the IP SLAs Responder is optional for a UDP echo operation when using Cisco devices. The IP SLAs Responder cannot be configured on non-Cisco devices.

The results of a UDP echo operation can be useful in troubleshooting issues with business-critical applications by determining the round-trip delay times and testing connectivity to both Cisco and non-Cisco devices.

How to Configure IP SLAs UDP Echo Operations

- Configuring the IP SLAs Responder on the Destination Device, page 92
- Configuring a UDP Echo Operation on the Source Device, page 93
- Scheduling IP SLAs Operations, page 98

Configuring the IP SLAs Responder on the Destination Device

If you are using the IP SLAs Responder, ensure that the networking device to be used as the responder is a Cisco device and that you have connectivity to that device through the network.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. Do one of the following:
   - **ip sla responder**
   - **ip sla responder udp-echo ipaddress** *ip-address* **port** *port*
4. **exit**

DETAILED STEPS

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

Step 3	Do one of the following:
	• **ip sla responder**
	• **ip sla responder udp-echo ipaddress** *ip-address* **port** *port*
	Example:
	`Router(config)# ip sla responder`
	Example:
	`Router(config)# ip sla responder udp-echo ipaddress 172.29.139.132 port 5000`
		(Optional) Temporarily enables IP SLAs Responder functionality on a Cisco device in response to control messages from source.
		or
		(Optional) Required only if protocol control is disabled on source. Permanently enables IP SLAs Responder functionality on specified IP address and port.
		• Control is enabled by default.

Step 4	**exit** **Example:** `Router(config)# exit`	(Optional) Exits global configuration mode and returns to privileged EXEC mode.

Configuring a UDP Echo Operation on the Source Device

Perform only one of the following tasks:

- Configuring a Basic UDP Echo Operation on the Source Device, page 94
- Configuring a UDP Echo Operation with Optional Parameters on the Source Device, page 95

Configuring a Basic UDP Echo Operation on the Source Device

If you are using the IP SLAs Responder, ensure that you have completed the "Configuring the IP SLAs Responder on the Destination Device" section before you start this task.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip sla** *operation-number*
4. **udp-echo** {*destination-ip-address* | *destination-hostname*} *destination-port* [**source-ip** {*ip-address* | *hostname*} **source-port** *port-number*] [**control** {**enable** | **disable**}]
5. **frequency** *seconds*
6. **exit**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**ip sla** *operation-number* **Example:** `Router(config)# ip sla 10`	Begins configuration for an IP SLAs operation and enters IP SLA configuration mode.
Step 4	**udp-echo** {*destination-ip-address* | *destination-hostname*} *destination-port* [**source-ip** {*ip-address* | *hostname*} **source-port** *port-number*] [**control** {**enable** | **disable**}] **Example:** `Router(config-ip-sla)# udp-echo 172.29.139.134 5000`	Defines a UDP echo operation and enters IP SLA UDP configuration mode. • Use the **control disable** keyword combination only if you disable the IP SLAs control protocol on both the source and target routers.
Step 5	**frequency** *seconds* **Example:** `Router(config-ip-sla-udp)# frequency 30`	(Optional) Sets the rate at which a specified IP SLAs operation repeats.
Step 6	**exit**	Exits IP SLA UDP configuration mode and returns to global configuration mode.

	Command or Action	Purpose
	Example: `Router(config-ip-sla-udp)# exit`	

Configuring a UDP Echo Operation with Optional Parameters on the Source Device

If you are using the IP SLAs Responder, ensure that you have completed the "Configuring the IP SLAs Responder on the Destination Device" section before you start this task.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip sla** *operation-number*
4. **udp-echo** {*destination-ip-address* | *destination-hostname*} *destination-port* [**source-ip** {*ip-address* | *hostname*} **source-port** *port-number*] [**control** {**enable** | **disable**}]
5. **history buckets-kept** *size*
6. **data-pattern** *hex-pattern*
7. **history distributions-of-statistics-kept** *size*
8. **history enhanced** [**interval** *seconds*] [**buckets** *number-of-buckets*]
9. **history filter** {**none** | **all** | **overThreshold** | **failures**}
10. **frequency** *seconds*
11. **history hours-of-statistics-kept** *hours*
12. **history lives-kept** *lives*
13. **owner** *owner-id*
14. **request-data-size** *bytes*
15. **history statistics-distribution-interval** *milliseconds*
16. **tag** *text*
17. **threshold** *milliseconds*
18. **timeout** *milliseconds*
19. Do one of the following:
    - **tos** *number*
    - **traffic-class** *number*
20. **flow-label** *number*
21. **verify-data**
22. **exit**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable**	Enables privileged EXEC mode.

	Command or Action	Purpose
	Example: `Router> enable`	• Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**ip sla** *operation-number* **Example:** `Router(config)# ip sla 10`	Begins configuration for an IP SLAs operation and enters IP SLA configuration mode.
Step 4	**udp-echo** {*destination-ip-address* | *destination-hostname*} *destination-port* [**source-ip** {*ip-address* | *hostname*} **source-port** *port-number*] [**control** {**enable** | **disable**}] **Example:** `Router(config-ip-sla)# udp-echo 172.29.139.134 5000`	Defines a UDP echo operation and enters IP SLA UDP configuration mode. • Use the **control disable** keyword combination only if you disable the IP SLAs control protocol on both the source and target routers.
Step 5	**history buckets-kept** *size* **Example:** `Router(config-ip-sla-udp)# history buckets-kept 25`	(Optional) Sets the number of history buckets that are kept during the lifetime of an IP SLAs operation.
Step 6	**data-pattern** *hex-pattern* **Example:** `Router(config-ip-sla-udp)# data-pattern`	(Optional) Specifies the data pattern in an IP SLAs operation to test for data corruption.
Step 7	**history distributions-of-statistics-kept** *size* **Example:** `Router(config-ip-sla-udp)# history distributions-of-statistics-kept 5`	(Optional) Sets the number of statistics distributions kept per hop during an IP SLAs operation.
Step 8	**history enhanced** [**interval** *seconds*] [**buckets** *number-of-buckets*] **Example:** `Router(config-ip-sla-udp)# history enhanced interval 900 buckets 100`	(Optional) Enables enhanced history gathering for an IP SLAs operation.

	Command or Action	Purpose

Step 9	**history filter** {**none** | **all** | **overThreshold** | **failures**}
	Example:
	`Router(config-ip-sla-udp)# history filter failures`
		(Optional) Defines the type of information kept in the history table for an IP SLAs operation.

Step 10	**frequency** *seconds* **Example:** `Router(config-ip-sla-udp)# frequency 30`	(Optional) Sets the rate at which a specified IP SLAs operation repeats.
Step 11	**history hours-of-statistics-kept** *hours* **Example:** `Router(config-ip-sla-udp)# history hours-of-statistics-kept 4`	(Optional) Sets the number of hours for which statistics are maintained for an IP SLAs operation.
Step 12	**history lives-kept** *lives* **Example:** `Router(config-ip-sla-udp)# history lives-kept 5`	(Optional) Sets the number of lives maintained in the history table for an IP SLAs operation.
Step 13	**owner** *owner-id* **Example:** `Router(config-ip-sla-udp)# owner admin`	(Optional) Configures the Simple Network Management Protocol (SNMP) owner of an IP SLAs operation.
Step 14	**request-data-size** *bytes* **Example:** `Router(config-ip-sla-udp)# request-data-size 64`	(Optional) Sets the protocol data size in the payload of an IP SLAs operation's request packet.
Step 15	**history statistics-distribution-interval** *milliseconds* **Example:** `Router(config-ip-sla-udp)# history statistics-distribution-interval 10`	(Optional) Sets the time interval for each statistics distribution kept for an IP SLAs operation.
Step 16	**tag** *text* **Example:** `Router(config-ip-sla-udp)# tag TelnetPollServer1`	(Optional) Creates a user-specified identifier for an IP SLAs operation.
Step 17	**threshold** *milliseconds*	(Optional) Sets the upper threshold value for calculating network monitoring statistics created by an IP SLAs operation.

	Command or Action	Purpose
	Example: `Router(config-ip-sla-udp)# threshold 10000`	
Step 18	**timeout** *milliseconds* **Example:** `Router(config-ip-sla-udp)# timeout 10000`	(Optional) Sets the amount of time an IP SLAs operation waits for a response from its request packet.

Step 19	Do one of the following:
	• **tos** *number*
	• **traffic-class** *number*
	Example:
	`Router(config-ip-sla-jitter)# tos 160`
	Example:
	`Router(config-ip-sla-jitter)# traffic-class 160`
		(Optional) In an IPv4 network only, defines the ToS byte in the IPv4 header of an IP SLAs operation.
		or
		(Optional) In an IPv6 network only, defines the traffic class byte in the IPv6 header for a supported IP SLAs operation.

Step 20	**flow-label** *number* **Example:** `Router(config-ip-sla-udp)# flow-label 112233`	(Optional) In an IPv6 network only, defines the flow label field in the IPv6 header for a supported IP SLAs operation.
Step 21	**verify-data** **Example:** `Router(config-ip-sla-udp)# verify-data`	(Optional) Causes an IP SLAs operation to check each reply packet for data corruption.
Step 22	**exit** **Example:** `Router(config-ip-sla-udp)# exit`	Exits UDP configuration submode and returns to global configuration mode.

Scheduling IP SLAs Operations

Note

- All IP SLAs operations to be scheduled must be already configured.
- The frequency of all operations scheduled in a multioperation group must be the same.
- List of one or more operation ID numbers to be added to a multioperation group is limited to a maximum of 125 characters, including commas (,).

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. Do one of the following:
    - **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**]
    - **ip sla group schedule** *group-operation-number operation-id-numbers* **schedule-period** *schedule-period-range* [**ageout** *seconds*] [**frequency** *group-operation-frequency*] [**life**{**forever** | *seconds*}] [**start-time**{*hh:mm*[*:ss*] [*month day* | *day month*] | **pending** | **now** | **after** *hh:mm:ss*}]
4. **exit**
5. **show ip sla group schedule**
6. **show ip sla configuration**

DETAILED STEPS

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

Step 3	Do one of the following:
	• **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**]
	• **ip sla group schedule** *group-operation-number operation-id-numbers* **schedule-period** *schedule-period-range* [**ageout** *seconds*] [**frequency** *group-operation-frequency*] [**life**{**forever** | *seconds*}] [**start-time**{*hh:mm*[*:ss*] [*month day* | *day month*] | **pending** | **now** | **after** *hh:mm:ss*}]
	Example:
	`Router(config)# ip sla schedule 10 start-time now life forever`
	Example:
	`Router(config)# ip sla group schedule 1 3,4,6-9`
		For individual IP SLAs operations only:
		Configures the scheduling parameters for an individual IP SLAs operation.
		or
		For multioperation scheduler only:
		Specifies an IP SLAs operation group number and the range of operation numbers to be scheduled in global configuration mode.

Step 4	**exit**	Exits to privileged EXEC mode.

	Command or Action	Purpose
	Example: `Router(config)# exit`	
Step 5	**show ip sla group schedule** **Example:** `Router# show ip sla group schedule`	(Optional) Displays the IP SLAs group schedule details.
Step 6	**show ip sla configuration** **Example:** `Router# show ip sla configuration`	(Optional) Displays the IP SLAs configuration details.

- Troubleshooting Tips, page 16
- What to Do Next, page 16

Troubleshooting Tips

- If the IP SLAs operation is not running and generating statistics, add the **verify-data** command to the configuration of the operation (while configuring in IP SLA configuration mode) to enable data verification. When enabled, each operation response is checked for corruption. Use the **verify-data** command with caution during normal operations because it generates unnecessary overhead.
- Use the **debugipsla trace** and **debug ip sla error** commands to help troubleshoot issues with an IP SLAs operation.

What to Do Next

To add proactive threshold conditions and reactive triggering for generating traps, or for starting another operation, to an IP SLAs operation, see the "Configuring Proactive Threshold Monitoring" section.

To view and interpret the results of an IP SLAs operation use the **show ip sla statistics** command. Checking the output for fields that correspond to criteria in your service level agreement will help you determine whether the service metrics are acceptable.

Configuration Examples for IP SLAs UDP Echo Operations

- Example Configuring a UDP Echo Operation, page 100

Example Configuring a UDP Echo Operation

The following example configures an IP SLAs operation type of UDP echo that will start immediately and run indefinitely.

```
ip sla 5
```

```
 udp-echo 172.29.139.134 5000
 frequency 30
 request-data-size 160
 tos 128
 timeout 1000
 tag FLL-RO
ip sla schedule 5 life forever start-time now
```

Additional References

Related Documents

Related Topic	Document Title
Cisco IOS commands	Cisco IOS Master Commands List, All Releases
Cisco IOS IP SLAs commands	*Cisco IOS IP SLAs Command Reference*

Standards

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

MIBs

MIBs	MIBs Link
• CISCO-RTTMON-MIB • IPV6-FLOW-LABEL-MIB	To locate and download MIBs for selected platforms, Cisco IOS releases, and feature sets, use Cisco MIB Locator found at the following URL: http://www.cisco.com/go/mibs

RFCs

RFCs	Title
RFC 862	Echo Protocol

Technical Assistance

Description	Link
The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most	http://www.cisco.com/cisco/web/support/index.html

Description	Link
tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.	

Feature Information for the IP SLAs UDP Echo Operation

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 http://www.cisco.com/go/cfn. An account on Cisco.com is not required.

Table 14: Feature Information for the IP SLAs UDP Echo Operation

Feature Name	Releases	Feature Information
IP SLAs UDP Jitter Operation	Cisco IOS XE Release 2.1	The IP SLAs User Datagram Protocol (UDP) jitter operation allows you to measure round-trip delay, one-way delay, one-way jitter, one-way packet loss, and connectivity in networks that carry UDP traffic.
IP SLAs for IPv6 (UDP Jitter, UDP Echo, ICMP Echo, TCP Connect)	Cisco IOS XE Release 2.1	Support was added for operability in IPv6 networks.

Any Internet Protocol (IP) addresses and phone numbers used in this document are not intended to be actual addresses and phone numbers. Any examples, command display output, network topology diagrams, and other figures included in the document are shown for illustrative purposes only. Any use of actual IP addresses or phone numbers in illustrative content is unintentional and coincidental.

Configuring IP SLAs HTTP Operations

This module describes how to configure an IP Service Level Agreements (SLAs) HTTP operation to monitor the response time between a Cisco device and an HTTP server to retrieve a web page. The IP SLAs HTTP operation supports both the normal GET requests and customer RAW requests. This module also demonstrates how the results of the HTTP operation can be displayed and analyzed to determine how an HTTP server is performing.

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest feature information and caveats, see the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the Feature Information Table at the end of this document.

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

Restrictions for IP SLAs HTTP Operations

- IP SLAs HTTP operations support only HTTP/1.0.
- HTTP/1.1 is not supported for any IP SLAs HTTP operation, including HTTP RAW requests.

Information About IP SLAs HTTP Operations

HTTP Operation

The HTTP operation measures the round-trip time (RTT) between a Cisco device and an HTTP server to retrieve a web page. The HTTP server response time measurements consist of three types:

- DNS lookup--RTT taken to perform domain name lookup.
- TCP Connect--RTT taken to perform a TCP connection to the HTTP server.
- HTTP transaction time--RTT taken to send a request and get a response from the HTTP server. The operation retrieves only the home HTML page.

The DNS operation is performed first and the DNS RTT is measured. Once the domain name is found, a TCP Connect operation to the appropriate HTTP server is performed and the RTT for this operation is measured. The final operation is an HTTP request and the RTT to retrieve the home HTML page from the HTTP server is measured. One other measurement is made and called the time to first byte which measures the time from the start of the TCP Connect operation to the first HTML byte retrieved by the HTTP operation. The total HTTP RTT is a sum of the DNS RTT, the TCP Connect RTT, and the HTTP RTT.

For GET requests, IP SLAs will format the request based on the specified URL. For RAW requests, IP SLAs requires the entire content of the HTTP request. When a RAW request is configured, the raw commands are specified in HTTP RAW configuration mode. A RAW request is flexible and allows you to control fields such as authentication. An HTTP request can be made through a proxy server.

The results of an HTTP operation can be useful in monitoring your web server performance levels by determining the RTT taken to retrieve a web page.

How to Configure IP SLAs HTTP Operations

- Configuring an HTTP GET Operation on the Source Device, page 104
- Configuring an HTTP RAW Operation on the Source Device, page 109
- Scheduling IP SLAs Operations, page 98

Configuring an HTTP GET Operation on the Source Device

Note This operation does not require an IP SLAs Responder on the destination device.

Perform only one of the following tasks:

- Configuring a Basic HTTP GET Operation on the Source Device, page 104
- Configuring an HTTP GET Operation with Optional Parameters on the Source Device, page 106

Configuring a Basic HTTP GET Operation on the Source Device

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip sla** *operation-number*
4. **http** {**get** | **raw**} *url* [**name-server** *ip-address*] [**version** *version-number*] [**source-ip** {*ip-address* | *hostname*}] [**source-port** *port-number*] [**cache** {**enable** | **disable**}] [**proxy** *proxy-url*]
5. **frequency** *seconds*
6. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**ip sla** *operation-number* **Example:** `Router(config)# ip sla 10`	Begins configuration for an IP SLAs operation and enters IP SLA configuration mode.
Step 4	**http** {**get** | **raw**} *url* [**name-server** *ip-address*] [**version** *version-number*] [**source-ip** {*ip-address* | *hostname*}] [**source-port** *port-number*] [**cache** {**enable** | **disable**}] [**proxy** *proxy-url*] **Example:** `Router(config-ip-sla)# http get http://198.133.219.25`	Defines an HTTP operation and enters IP SLA configuration mode.
Step 5	**frequency** *seconds* **Example:** `Router(config-ip-sla-http)# frequency 90`	(Optional) Sets the rate at which a specified IP SLAs HTTP operation repeats. The default and minimum frequency value for an IP SLAs HTTP operation is 60 seconds.

Step 6	**end**
	Example:
	`Router(config-ip-sla-http)# end`
		Exits to privileged EXEC mode.

Configuring an HTTP GET Operation with Optional Parameters on the Source Device

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip sla** *operation-number*
4. **http** {**get** | **raw**} *url* [**name-server** *ip-address*] [**version** *version-number*] [**source-ip** {*ip-address* | *hostname*}] [**source-port** *port-number*] [**cache** {**enable** | **disable**}] [**proxy** *proxy-url*]
5. **history buckets-kept** *size*
6. **history distributions-of-statistics-kept** *size*
7. **history enhanced** [**interval** *seconds*] [**buckets** *number-of-buckets*]
8. **history filter** {**none** | **all** | **overThreshold** | **failures**}
9. **frequency** *seconds*
10. **history hours-of-statistics-kept** *hours*
11. **http-raw-request**
12. **history lives-kept** *lives*
13. **owner** *owner-id*
14. **history statistics-distribution-interval** *milliseconds*
15. **tag** *text*
16. **threshold** *milliseconds*
17. **timeout** *milliseconds*
18. **tos** *number*
19. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**ip sla** *operation-number* **Example:** `Router(config)# ip sla 10`	Begins configuration for an IP SLAs operation and enters IP SLA configuration mode.

	Command or Action	Purpose
Step 4	**http** {**get** | **raw**} *url* [**name-server** *ip-address*] [**version** *version-number*] [**source-ip** {*ip-address* | *hostname*}] [**source-port** *port-number*] [**cache** {**enable** | **disable**}] [**proxy** *proxy-url*] **Example:** `Router(config-ip-sla)# http get http://198.133.219.25`	Defines an HTTP operation and enters IP SLA configuration mode.
Step 5	**history buckets-kept** *size* **Example:** `Router(config-ip-sla-http)# history buckets-kept 25`	(Optional) Sets the number of history buckets that are kept during the lifetime of an IP SLAs operation.
Step 6	**history distributions-of-statistics-kept** *size* **Example:** `Router(config-ip-sla-http)# history distributions-of-statistics-kept 5`	(Optional) Sets the number of statistics distributions kept per hop during an IP SLAs operation.
Step 7	**history enhanced** [**interval** *seconds*] [**buckets** *number-of-buckets*] **Example:** `Router(config-ip-sla-http)# history enhanced interval 900 buckets 100`	(Optional) Enables enhanced history gathering for an IP SLAs operation.

Step 8	**history filter** {**none** | **all** | **overThreshold** | **failures**}
	Example:
	`Router(config-ip-sla-http)# history filter failures`
		(Optional) Defines the type of information kept in the history table for an IP SLAs operation.

Step 9	**frequency** *seconds* **Example:** `Router(config-ip-sla-http)# frequency 90`	(Optional) Sets the rate at which a specified IP SLAs HTTP operation repeats. The default and minimum frequency value for an IP SLAs HTTP operation is 60 seconds.
Step 10	**history hours-of-statistics-kept** *hours* **Example:** `Router(config-ip-sla-http)# history hours-of-statistics-kept 4`	(Optional) Sets the number of hours for which statistics are maintained for an IP SLAs operation.
Step 11	**http-raw-request**	(Optional) Explicitly specifies the options for a GET request for an IP SLAs HTTP operation.

	Command or Action	Purpose
	Example: `Router(config-ip-sla-http)# http-raw-request`	
Step 12	**history lives-kept** *lives* **Example:** `Router(config-ip-sla-http)# history lives-kept 5`	(Optional) Sets the number of lives maintained in the history table for an IP SLAs operation.
Step 13	**owner** *owner-id* **Example:** `Router(config-ip-sla-http)# owner admin`	(Optional) Configures the Simple Network Management Protocol (SNMP) owner of an IP SLAs operation.
Step 14	**history statistics-distribution-interval** *milliseconds* **Example:** `Router(config-ip-sla-http)# history statistics-distribution-interval 10`	(Optional) Sets the time interval for each statistics distribution kept for an IP SLAs operation.
Step 15	**tag** *text* **Example:** `Router(config-ip-sla-http)# tag TelnetPollServer1`	(Optional) Creates a user-specified identifier for an IP SLAs operation.
Step 16	**threshold** *milliseconds* **Example:** `Router(config-ip-sla-http)# threshold 10000`	(Optional) Sets the upper threshold value for calculating network monitoring statistics created by an IP SLAs operation.
Step 17	**timeout** *milliseconds* **Example:** `Router(config-ip-sla-http)# timeout 10000`	(Optional) Sets the amount of time an IP SLAs operation waits for a response from its request packet.
Step 18	**tos** *number* **Example:** `Router(config-ip-sla-http)# tos 160`	(Optional) Defines a type of service (ToS) byte in the IP header of an IP SLAs operation.

Step 19	**end**
	Example:
	`Router(config-ip-sla-http)# end`
		Exits to privileged EXEC mode.

Configuring an HTTP RAW Operation on the Source Device

Note This operation does not require an IP SLAs Responder on the destination device.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip sla** *operation-number*
4. **http** {**get** | **raw**} *url* [**name-server** *ip-address*] [**version** *version-number*] [**source-ip** {*ip-address* | *hostname*}] [**source-port** *port-number*] [**cache** {**enable** | **disable**}] [**proxy** *proxy-url*]
5. **http-raw-request**
6. Enter the required HTTP 1.0 command syntax.
7. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**ip sla** *operation-number* **Example:** `Router(config)# ip sla 10`	Begins configuration for an IP SLAs operation and enters IP SLA configuration mode.
Step 4	**http** {**get** | **raw**} *url* [**name-server** *ip-address*] [**version** *version-number*] [**source-ip** {*ip-address* | *hostname*}] [**source-port** *port-number*] [**cache** {**enable** | **disable**}] [**proxy** *proxy-url*] **Example:** `Router(config-ip-sla)# http raw http://198.133.219.25`	Defines an HTTP operation.
Step 5	**http-raw-request** **Example:** `Router(config-ip-sla)# http-raw-request`	Enters HTTP RAW configuration mode.

	Command or Action	Purpose
Step 6	Enter the required HTTP 1.0 command syntax. **Example:** `Router(config-ip-sla-http)# GET /en/US/hmpgs/index.html HTTP/1.0\r \n\r\n`	Specifies all the required HTTP 1.0 commands.

Step 7	**end**
	Example:
	`Router(config-ip-sla-http)# end`
		Exits to privileged EXEC mode.

Scheduling IP SLAs Operations

Note

- All IP SLAs operations to be scheduled must be already configured.
- The frequency of all operations scheduled in a multioperation group must be the same.
- List of one or more operation ID numbers to be added to a multioperation group is limited to a maximum of 125 characters, including commas (,).

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. Do one of the following:
   - **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**]
   - **ip sla group schedule** *group-operation-number operation-id-numbers* **schedule-period** *schedule-period-range* [**ageout** *seconds*] [**frequency** *group-operation-frequency*] [**life**{**forever** | *seconds*}] [**start-time**{*hh:mm*[*:ss*] [*month day* | *day month*] | **pending** | **now** | **after** *hh:mm:ss*}]
4. **exit**
5. **show ip sla group schedule**
6. **show ip sla configuration**

DETAILED STEPS

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

	Command or Action	Purpose
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.

Step 3	Do one of the following:
	• **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**]
	• **ip sla group schedule** *group-operation-number operation-id-numbers* **schedule-period** *schedule-period-range* [**ageout** *seconds*] [**frequency** *group-operation-frequency*] [**life**{**forever** | *seconds*}] [**start-time**{*hh:mm*[*:ss*] [*month day* | *day month*] | **pending** | **now** | **after** *hh:mm:ss*}]
	Example:
	`Router(config)# ip sla schedule 10 start-time now life forever`
	Example:
	`Router(config)# ip sla group schedule 1 3,4,6-9`
		For individual IP SLAs operations only:
		Configures the scheduling parameters for an individual IP SLAs operation.
		or
		For multioperation scheduler only:
		Specifies an IP SLAs operation group number and the range of operation numbers to be scheduled in global configuration mode.

Step 4	**exit** **Example:** `Router(config)# exit`	Exits to privileged EXEC mode.
Step 5	**show ip sla group schedule** **Example:** `Router# show ip sla group schedule`	(Optional) Displays the IP SLAs group schedule details.
Step 6	**show ip sla configuration** **Example:** `Router# show ip sla configuration`	(Optional) Displays the IP SLAs configuration details.

- Troubleshooting Tips, page 16
- What to Do Next, page 16

Troubleshooting Tips

- If the IP SLAs operation is not running and generating statistics, add the **verify-data** command to the configuration of the operation (while configuring in IP SLA configuration mode) to enable data verification. When enabled, each operation response is checked for corruption. Use the **verify-data** command with caution during normal operations because it generates unnecessary overhead.

- Use the **debugipsla trace** and **debug ip sla error** commands to help troubleshoot issues with an IP SLAs operation.

What to Do Next

To add proactive threshold conditions and reactive triggering for generating traps, or for starting another operation, to an IP SLAs operation, see the "Configuring Proactive Threshold Monitoring" section.

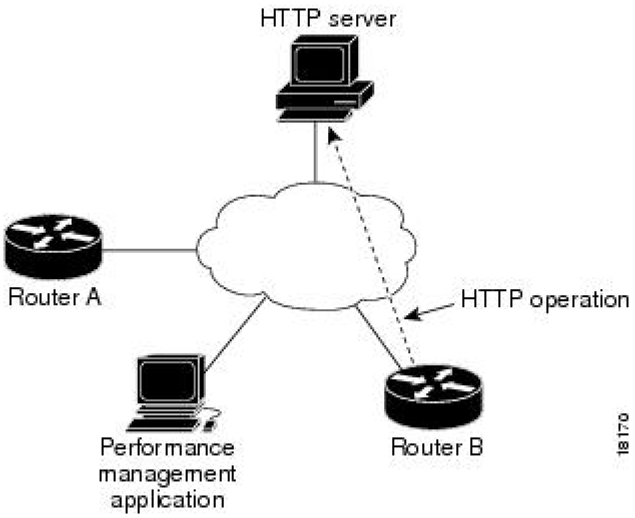
To view and interpret the results of an IP SLAs operation use the **show ip sla statistics** command. Checking the output for fields that correspond to criteria in your service level agreement will help you determine whether the service metrics are acceptable.

Configuration Examples for IP SLAs HTTP Operations

Example Configuring an HTTP GET Operation

The following example show how to create and configure operation number 8 as an HTTP GET operation. The destination URL IP address represents the www.cisco.com website. The following figure depicts the HTTP GET operation.

Figure 10: HTTP Operation



Router B Configuration

```
ip sla 8
 http get url http://198.133.219.25
!
ip sla schedule 8 start-time now
```

Example Configuring an HTTP RAW Operation

The following example shows how to configure an HTTP RAW operation. To use the RAW commands, enter HTTP RAW configuration mode by using the **http-raw-request** command in IP SLA configuration mode. The IP SLA HTTP RAW configuration mode is indicated by the (config-ip-sla-http) router prompt.

```
ip sla 8
 http raw url http://198.133.219.25
 http-raw-request
 GET /en/US/hmpgs/index.html HTTP/1.0\r\n
 \r\n
 end
ip sla schedule 8 life forever start-time now
```

Example Configuring an HTTP RAW Operation Through a Proxy Server

The following example shows how to configure an HTTP RAW operation through a proxy server. The proxy server is www.proxy.cisco.com and the HTTP server is www.yahoo.com.

```
ip sla 8
 http raw url http://www.proxy.cisco.com
 http-raw-request
 GET http://www.yahoo.com HTTP/1.0\r\n
 \r\n
 end
ip sla schedule 8 life forever start-time now
```

Example Configuring an HTTP RAW Operation with Authentication

The following example shows how to configure an HTTP RAW operation with authentication.

```
ip sla 8
 http raw url http://site-test.cisco.com
 http-raw-request
 GET /lab/index.html HTTP/1.0\r\n
 Authorization: Basic btNpdGT4biNvoZe=\r\n
 \r\n
 end
ip sla schedule 8 life forever start-time now
```

Additional References

Related Documents

Related Topic	Document Title
Cisco IOS commands	Cisco IOS Master Commands List, All Releases
Cisco IOS IP SLAs commands	*Cisco IOS IP SLAs Command Reference*

Standards

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

MIBs

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

RFCs

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

Technical Assistance

Description	Link
The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.	http://www.cisco.com/cisco/web/support/index.html

Feature Information for IP SLAs HTTP Operations

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 http://www.cisco.com/go/cfn. An account on Cisco.com is not required.

Table 15: Feature Information for the IP SLAs HTTP Operation

Feature Name	Releases	Feature Information
IP SLAs HTTP Operation	Cisco IOS XE Release 2.1	The Cisco IOS XE IP SLAs Hypertext Transfer Protocol (HTTP) operation allows you to measure the network response time between a Cisco device and an HTTP server to retrieve a web page.

Any Internet Protocol (IP) addresses and phone numbers used in this document are not intended to be actual addresses and phone numbers. Any examples, command display output, network topology diagrams, and other figures included in the document are shown for illustrative purposes only. Any use of actual IP addresses or phone numbers in illustrative content is unintentional and coincidental.

Configuring IP SLAs TCP Connect Operations

This module describes how to configure an IP Service Level Agreements (SLAs) TCP Connect operation to measure the response time taken to perform a TCP Connect operation between a Cisco router and devices using IPv4 or IPv6. TCP Connect accuracy is enhanced by using the IP SLAs Responder at the destination Cisco router. This module also demonstrates how the results of the TCP Connect operation can be displayed and analyzed to determine how the connection times to servers and hosts within your network can affect IP service levels. The TCP Connect operation is useful for measuring response times for a server used for a particular application or connectivity testing for server availability.

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest feature information and caveats, see the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the Feature Information Table at the end of this document.

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

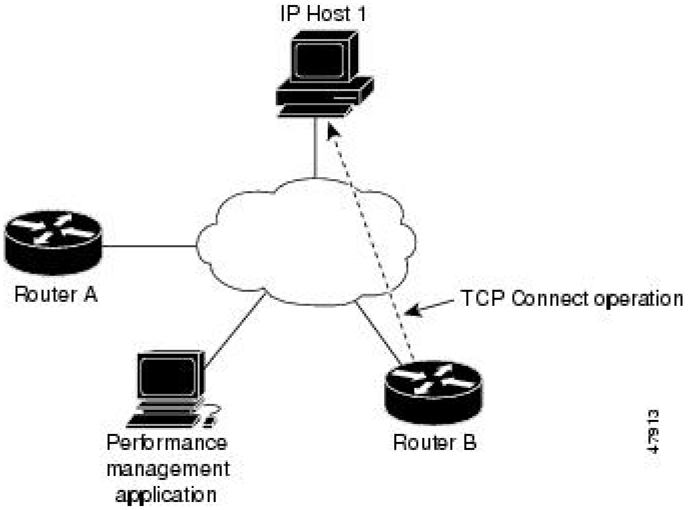
Information About the IP SLAs TCP Connect Operation

TCP Connect Operation

The IP SLAs TCP Connect operation measures the response time taken to perform a TCP Connect operation between a Cisco router and devices using IP. TCP is a transport layer (Layer 4) Internet protocol that provides reliable full-duplex data transmission. The destination device can be any device using IP or an IP SLAs Responder.

In the figure below Router B is configured as the source IP SLAs device and a TCP Connect operation is configured with the destination device as IP Host 1.

Figure 11: TCP Connect Operation



Connection response time is computed by measuring the time taken between sending a TCP request message from Router B to IP Host 1 and receiving a reply from IP Host 1.

TCP Connect accuracy is enhanced by using the IP SLAs Responder at the destination Cisco device. If the destination router is a Cisco router, then IP SLAs makes a TCP connection to any port number that you specified. If the destination is not a Cisco IP host, then you must specify a known destination port number such as 21 for FTP, 23 for Telnet, or 80 for an HTTP server.

Using the IP SLAs Responder is optional for a TCP Connect operation when using Cisco devices. The IP SLAs Responder cannot be configured on non-Cisco devices.

TCP Connect is used to test virtual circuit availability or application availability. Server and application connection performance can be tested by simulating Telnet, SQL, and other types of connection to help you verify your IP service levels.

How to Configure the IP SLAs TCP Connect Operation

- Configuring the IP SLAs Responder on the Destination Device, page 118
- Configuring and Scheduling a TCP Connect Operation on the Source Device, page 119

Configuring the IP SLAs Responder on the Destination Device

If you are using the IP SLAs Responder, ensure that the networking device to be used as the Responder is a Cisco device and that you have connectivity to that device through the network.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. Do one of the following:
   - **ip sla responder**
   - **ip sla responder tcp-connect ipaddress** *ip-address* **port** *port*
4. **exit**

DETAILED STEPS

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

Step 3	Do one of the following:
	• **ip sla responder**
	• **ip sla responder tcp-connect ipaddress** *ip-address* **port** *port*
	Example:
	`Router(config)# ip sla responder`
	Example:
	`Router(config)# ip sla responder tcp-connect ipaddress 172.29.139.132 port 5000`
		(Optional) Temporarily enables IP SLAs Responder functionality on a Cisco device in response to control messages from source.
		or
		(Optional) Required only if protocol control is disabled on source. Permanently enables IP SLAs Responder functionality on specified IP address and port.
		• Control is enabled by default.

Step 4	**exit** **Example:** `Router(config)# exit`	(Optional) Exits global configuration mode and returns to privileged EXEC mode.

Configuring and Scheduling a TCP Connect Operation on the Source Device

Perform only one of the following tasks:

- Prerequisites, page 120
- Configuring and Scheduling a Basic TCP Connect Operation on the Source Device, page 120

- Configuring and Scheduling a TCP Connect Operation with Optional Parameters on the Source Device, page 122

Prerequisites

If you are using the IP SLAs Responder, complete the "Configuring the IP SLAs Responder on the Destination Device" section before you start this task.

Configuring and Scheduling a Basic TCP Connect Operation on the Source Device

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip sla** *operation-number*
4. **tcp-connect** {*destination-ip-address* | *destination-hostname*} *destination-port* [**source-ip** {*ip-address* | *hostname*} **source-port** *port-number*] [**control** {**enable** | **disable**}]
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. **exit**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**ip sla** *operation-number* **Example:** `Router(config)# ip sla 10`	Begins configuration for an IP SLAs operation and enters IP SLA configuration mode.
Step 4	**tcp-connect** {*destination-ip-address* | *destination-hostname*} *destination-port* [**source-ip** {*ip-address* | *hostname*} **source-port** *port-number*] [**control** {**enable** | **disable**}]	Defines a TCP Connect operation and enters IP SLA TCP configuration mode. • Use the **control disable** keyword combination only if you disable the IP SLAs control protocol on both the source and target routers.

	Command or Action	Purpose
	Example: `Router(config-ip-sla)# tcp-connect 172.29.139.132 5000`	
Step 5	**frequency** *seconds* **Example:** `Router(config-ip-sla-tcp)# frequency 30`	(Optional) Sets the rate at which a specified IP SLAs operation repeats.
Step 6	**exit** **Example:** `Router(config-ip-sla-tcp)# exit`	Exits IP SLA TCP 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:** `Router(config)# ip sla schedule 10 start-time now life forever`	Configures the scheduling parameters for an individual IP SLAs operation.
Step 8	**exit** **Example:** `Router(config)# exit`	(Optional) Exits the global configuration mode and returns to privileged EXEC mode.

Example

The following example shows the configuration of an IP SLAs operation type of TCP Connect that will start immediately and run indefinitely.

```
ip sla 9
 tcp-connect 172.29.139.132 5000
 frequency 10
!
ip sla schedule 9 life forever start-time now
```

- Troubleshooting Tips, page 16
- What to Do Next, page 16

Troubleshooting Tips

- If the IP SLAs operation is not running and generating statistics, add the **verify-data** command to the configuration of the operation (while configuring in IP SLA configuration mode) to enable data verification. When enabled, each operation response is checked for corruption. Use the **verify-data** command with caution during normal operations because it generates unnecessary overhead.
- Use the **debugipsla trace** and **debug ip sla error** commands to help troubleshoot issues with an IP SLAs operation.

What to Do Next

To add proactive threshold conditions and reactive triggering for generating traps, or for starting another operation, to an IP SLAs operation, see the "Configuring Proactive Threshold Monitoring" section.

To view and interpret the results of an IP SLAs operation use the **show ip sla statistics** command. Checking the output for fields that correspond to criteria in your service level agreement will help you determine whether the service metrics are acceptable.

Configuring and Scheduling a TCP Connect Operation with Optional Parameters on the Source Device

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip sla** *operation-number*
4. **tcp-connect** {*destination-ip-address* | *destination-hostname*} *destination-port* [**source-ip** {*ip-address* | *hostname*} **source-port** *port-number*] [**control** {**enable** | **disable**}]
5. **history buckets-kept** *size*
6. **history distributions-of-statistics-kept** *size*
7. **history enhanced** [**interval** *seconds*] [**buckets** *number-of-buckets*]
8. **history filter** {**none** | **all** | **overThreshold** | **failures**}
9. **frequency** *seconds*
10. **history hours-of-statistics-kept** *hours*
11. **history lives-kept** *lives*
12. **owner** *owner-id*
13. **history statistics-distribution-interval** *milliseconds*
14. **tag** *text*
15. **threshold** *milliseconds*
16. **timeout** *milliseconds*
17. Do one of the following:
    - **tos** *number*
    - **traffic-class** *number*
18. **flow-label** *number*
19. **exit**
20. **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**]
21. **exit**
22. **show ip sla configuration** [*operation-number*]

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. - Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**ip sla** *operation-number* **Example:** `Router(config)# ip sla 10`	Begins configuration for an IP SLAs operation and enters IP SLA configuration mode.
Step 4	**tcp-connect** {*destination-ip-address* | *destination-hostname*} *destination-port* [**source-ip** {*ip-address* | *hostname*} **source-port** *port-number*] [**control** {**enable** | **disable**}] **Example:** `Router(config-ip-sla)# tcp-connect 172.29.139.132 5000`	Defines a TCP Connect operation and enters IP SLA TCP configuration mode. - Use the **control disable** keyword combination only if you disable the IP SLAs control protocol on both the source and target routers.
Step 5	**history buckets-kept** *size* **Example:** `Router(config-ip-sla-tcp)# history buckets-kept 25`	(Optional) Sets the number of history buckets that are kept during the lifetime of an IP SLAs operation.
Step 6	**history distributions-of-statistics-kept** *size* **Example:** `Router(config-ip-sla-tcp)# history distributions-of-statistics-kept 5`	(Optional) Sets the number of statistics distributions kept per hop during an IP SLAs operation.
Step 7	**history enhanced** [**interval** *seconds*] [**buckets** *number-of-buckets*] **Example:** `Router(config-ip-sla-tcp)# history enhanced interval 900 buckets 100`	(Optional) Enables enhanced history gathering for an IP SLAs operation.
Step 8	**history filter** {**none** | **all** | **overThreshold** | **failures**}	(Optional) Defines the type of information kept in the history table for an IP SLAs operation.

	Command or Action	Purpose
	Example: `Router(config-ip-sla-tcp)# history filter failures`	
Step 9	**frequency** *seconds* **Example:** `Router(config-ip-sla-tcp)# frequency 30`	(Optional) Sets the rate at which a specified IP SLAs operation repeats.
Step 10	**history hours-of-statistics-kept** *hours* **Example:** `Router(config-ip-sla-tcp)# history hours-of-statistics-kept 4`	(Optional) Sets the number of hours for which statistics are maintained for an IP SLAs operation.
Step 11	**history lives-kept** *lives* **Example:** `Router(config-ip-sla-tcp)# history lives-kept 5`	(Optional) Sets the number of lives maintained in the history table for an IP SLAs operation.
Step 12	**owner** *owner-id* **Example:** `Router(config-ip-sla-tcp)# owner admin`	(Optional) Configures the Simple Network Management Protocol (SNMP) owner of an IP SLAs operation.
Step 13	**history statistics-distribution-interval** *milliseconds* **Example:** `Router(config-ip-sla-tcp)# history statistics-distribution-interval 10`	(Optional) Sets the time interval for each statistics distribution kept for an IP SLAs operation.
Step 14	**tag** *text* **Example:** `Router(config-ip-sla-tcp)# tag TelnetPollServer1`	(Optional) Creates a user-specified identifier for an IP SLAs operation.
Step 15	**threshold** *milliseconds* **Example:** `Router(config-ip-sla-tcp)# threshold 10000`	(Optional) Sets the upper threshold value for calculating network monitoring statistics created by an IP SLAs operation.
Step 16	**timeout** *milliseconds* **Example:** `Router(config-ip-sla-tcp)# timeout 10000`	(Optional) Sets the amount of time an IP SLAs operation waits for a response from its request packet.

	Command or Action	Purpose

Step 17	Do one of the following:
	• **tos** *number*
	• **traffic-class** *number*
	Example:
	`Router(config-ip-sla-jitter)# tos 160`
	Example:
	`Router(config-ip-sla-jitter)# traffic-class 160`
		(Optional) In an IPv4 network only, defines the ToS byte in the IPv4 header of an IP SLAs operation.
		or
		(Optional) In an IPv6 network only, defines the traffic class byte in the IPv6 header for a supported IP SLAs operation.

Step 18	**flow-label** *number* **Example:** `Router(config-ip-sla-tcp)# flow-label 112233`	(Optional) In an IPv6 network only, defines the flow label field in the IPv6 header for a supported IP SLAs operation.
Step 19	**exit** **Example:** `Router(config-ip-sla-tcp)# exit`	Exits TCP configuration submode and returns to global configuration mode.
Step 20	**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:** `Router(config)# ip sla schedule 10 start-time now life forever`	Configures the scheduling parameters for an individual IP SLAs operation.
Step 21	**exit** **Example:** `Router(config)# exit`	(Optional) Exits global configuration mode and returns to privileged EXEC mode.
Step 22	**show ip sla configuration** [*operation-number*] **Example:** `Router# show ip sla configuration 10`	(Optional) Displays configuration values including all defaults for all IP SLAs operations or a specified operation.

Example

The following sample output shows the configuration of all the IP SLAs parameters (including defaults) for the TCP Connect operation number 9.

```
Router# show ip sla configuration 9
Complete Configuration Table (includes defaults)
Entry Number: 9
Owner:
```

```
Tag: SL-SGU
Type of Operation to Perform: tcpConnect
Reaction and History Threshold (milliseconds): 5000
Operation Frequency (seconds): 20
Operation Timeout (milliseconds): 60000
Verify Data: FALSE
Status of Entry (SNMP RowStatus): active
Protocol Type: ipTcpConn
Target Address: 172.29.139.132
Source Address: 0.0.0.0
Target Port: 5000
Source Port: 0
Request Size (ARR data portion): 1
Response Size (ARR data portion): 1
Control Packets: enabled
Loose Source Routing: disabled
LSR Path:
Type of Service Parameters: 128
Life (seconds): infinite - runs forever
Next Scheduled Start Time: Start Time already passed
Entry Ageout (seconds): never
Connection Loss Reaction Enabled: FALSE
Timeout Reaction Enabled: FALSE
Threshold Reaction Type: never
Threshold Falling (milliseconds): 3000
Threshold Count: 5
Threshold Count2: 5
Reaction Type: none
Verify Error Reaction Enabled: FALSE
Number of Statistic Hours kept: 2
Number of Statistic Paths kept: 1
Number of Statistic Hops kept: 1
Number of Statistic Distribution Buckets kept: 1
Statistic Distribution Interval (milliseconds): 20
Number of History Lives kept: 0
Number of History Buckets kept: 15
Number of History Samples kept: 1
History Filter Type: none
```

- Troubleshooting Tips, page 16
- What to Do Next, page 16

Troubleshooting Tips

- If the IP SLAs operation is not running and generating statistics, add the **verify-data** command to the configuration of the operation (while configuring in IP SLA configuration mode) to enable data verification. When enabled, each operation response is checked for corruption. Use the **verify-data** command with caution during normal operations because it generates unnecessary overhead.
- Use the **debugipsla trace** and **debug ip sla error** commands to help troubleshoot issues with an IP SLAs operation.

What to Do Next

To add proactive threshold conditions and reactive triggering for generating traps, or for starting another operation, to an IP SLAs operation, see the "Configuring Proactive Threshold Monitoring" section.

To view and interpret the results of an IP SLAs operation use the **show ip sla statistics** command. Checking the output for fields that correspond to criteria in your service level agreement will help you determine whether the service metrics are acceptable.

Configuration Examples for IP SLAs TCP Connect Operations

Example Configuring a TCP Connect Operation

The following example shows how to configure a TCP Connect operation from Router B to the Telnet port (TCP port 23) of IP Host 1 (IP address 10.0.0.1), as shown in the "TCP Connect Operation" figure in the "Information About the IP SLAs TCP Connect Operation" section. The operation is scheduled to start immediately. In this example, the control protocol is disabled on source (Router B). IP SLAs uses the control protocol to notify the IP SLAs Responder to enable the target port temporarily. This action allows the Responder to reply to the TCP Connect operation. In this example, because the target is not a router and a well-known TCP port is used, there is no need to send the control message.

Router A Configuration

```
configure terminal
 ip sla responder tcp-connect ipaddress 10.0.0.1 port 23
```

Router B Configuration

```
ip sla 9
 tcp-connect 10.0.0.1 23 control disable
 frequency 30
 tos 128
 timeout 1000
 tag FLL-RO
ip sla schedule 9 start-time now
```

The following example shows how to configure a TCP Connect operation with a specific port, port 23, and without an IP SLAs Responder. The operation is scheduled to start immediately and run indefinitely.

```
ip sla 9
 tcp-connect 173.29.139.132 21 control disable
 frequency 30
ip sla schedule 9 life forever start-time now
```

Additional References

Related Documents

Related Topic	Document Title
Cisco IOS commands	Cisco IOS Master Commands List, All Releases
Cisco IOS IP SLAs commands	*Cisco IOS IP SLAs Command Reference*

Standards

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

MIBs

MIBs	MIBs Link
• CISCO-RTTMON-MIB • IPV6-FLOW-LABEL-MIB	To locate and download MIBs for selected platforms, Cisco IOS releases, and feature sets, use Cisco MIB Locator found at the following URL: http://www.cisco.com/go/mibs

RFCs

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

Technical Assistance

Description	Link
The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.	http://www.cisco.com/cisco/web/support/index.html

Feature Information for the IP SLAs TCP Connect Operation

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 http://www.cisco.com/go/cfn. An account on Cisco.com is not required.

Table 16: Feature Information for the IP SLAs TCP Connect Operation

Feature Name	Releases	Feature Information
IP SLAs TCP Connect Operation	Cisco IOS XE Release 2.1	The IP SLAs Transmission Control Protocol (TCP) Connect operation allows you to measure the network response time taken to perform a TCP Connect operation between a Cisco device and other devices using IP.
IP SLAs for IPv6 (UDP Jitter, UDP Echo, ICMP Echo, TCP Connect)	Cisco IOS XE Release 2.1	Support was added for operability in IPv6 networks.

Any Internet Protocol (IP) addresses and phone numbers used in this document are not intended to be actual addresses and phone numbers. Any examples, command display output, network topology diagrams, and other figures included in the document are shown for illustrative purposes only. Any use of actual IP addresses or phone numbers in illustrative content is unintentional and coincidental.

Configuring IP SLAs ICMP Echo Operations

This module describes how to configure an IP Service Level Agreements (SLAs) Internet Control Message Protocol (ICMP) Echo operation to monitor end-to-end response time between a Cisco router and devices using IPv4 or IPv6. ICMP Echo is useful for troubleshooting network connectivity issues. This module also demonstrates how the results of the ICMP Echo operation can be displayed and analyzed to determine how the network IP connections are performing.

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest feature information and caveats, see the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the Feature Information Table at the end of this document.

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

Restrictions for IP SLAs ICMP Echo Operations

We recommend using a Cisco networking device as the destination device although any networking device that supports RFC 862, Echo protocol, can be used.

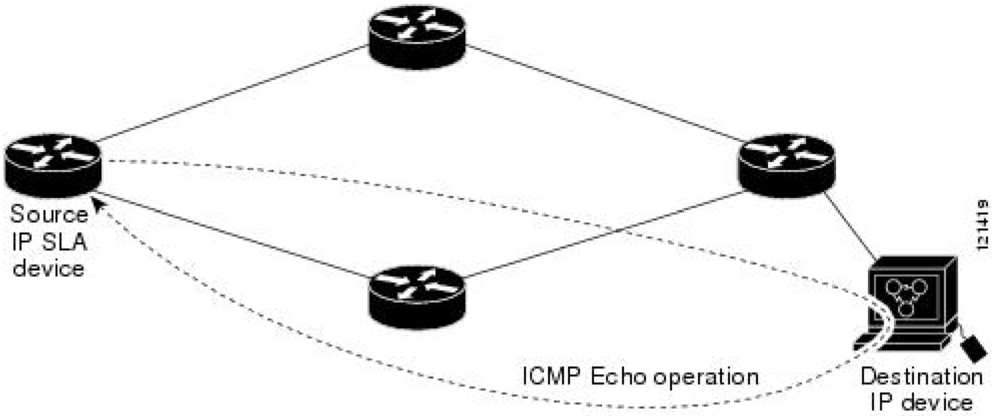
Information About IP SLAs ICMP Echo Operations

ICMP Echo Operation

The ICMP Echo operation measures end-to-end response time between a Cisco router and any devices using IP. Response time is computed by measuring the time taken between sending an ICMP Echo request message to the destination and receiving an ICMP Echo reply.

In the figure below ping is used by the ICMP Echo operation to measure the response time between the source IP SLAs device and the destination IP device. Many customers use IP SLAs ICMP-based operations, in-house ping testing, or ping-based dedicated probes for response time measurements.

Figure 12: ICMP Echo Operation



The IP SLAs ICMP Echo operation conforms to the same IETF specifications for ICMP ping testing and the two methods result in the same response times.

How to Configure IP SLAs ICMP Echo Operations

- Configuring an ICMP Echo Operation, page 132
- Scheduling IP SLAs Operations, page 98

Configuring an ICMP Echo Operation

Note There is no need to configure an IP SLAs responder on the destination device.

Perform one of the following tasks:

- Configuring a Basic ICMP Echo Operation on the Source Device, page 132
- Configuring an ICMP Echo Operation with Optional Parameters on the Source Device, page 134

Configuring a Basic ICMP Echo Operation on the Source Device

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-name*]
5. **frequency** *seconds*
6. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**ip sla** *operation-number* **Example:** `Router(config)# ip sla 6`	Begins configuration for an IP SLAs operation and enters IP SLA configuration mode.
Step 4	**icmp-echo** {*destination-ip-address* | *destination-hostname*} [**source-ip** {*ip-address* | *hostname*} | **source-interface** *interface-name*] **Example:** `Router(config-ip-sla)# icmp-echo 172.29.139.134`	Defines an ICMP Echo operation and enters IP SLA ICMP Echo configuration mode.
Step 5	**frequency** *seconds* **Example:** `Router(config-ip-sla-echo)# frequency 300`	(Optional) Sets the rate at which a specified IP SLAs operation repeats.

Step 6	**end**
	Example:
	`Router(config-ip-sla-echo)# end`
		Exits to privileged EXEC mode.

Configuring an ICMP Echo Operation with Optional Parameters on the Source Device

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-name*]
5. **history buckets-kept** *size*
6. **history distributions-of-statistics-kept** *size*
7. **history enhanced** [**interval** *seconds*] [**buckets** *number-of-buckets*]
8. **history filter** {**none** | **all** | **overThreshold** | **failures**}
9. **frequency** *seconds*
10. **history hours-of-statistics-kept** *hours*
11. **history lives-kept** *lives*
12. **owner** *owner-id*
13. **request-data-size** *bytes*
14. **history statistics-distribution-interval** *milliseconds*
15. **tag** *text*
16. **threshold** *milliseconds*
17. **timeout** *milliseconds*
18. Do one of the following:
    - **tos** *number*
    - **traffic-class** *number*
19. **flow-label** *number*
20. **verify-data**
21. **vrf** *vrf-name*
22. **end**

DETAILED STEPS

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

	Command or Action	Purpose
Step 3	**ip sla** *operation-number* **Example:** `Router(config)# ip sla 6`	Begins configuration for an IP SLAs operation and enters IP SLA configuration mode.
Step 4	**icmp-echo** {*destination-ip-address* | *destination-hostname*} [**source-ip** {*ip-address* | *hostname*} | **source-interface** *interface-name*] **Example:** `Router(config-ip-sla)# icmp-echo 172.29.139.134 source-ip 172.29.139.132`	Defines an Echo operation and enters IP SLA Echo configuration mode.
Step 5	**history buckets-kept** *size* **Example:** `Router(config-ip-sla-echo)# history buckets-kept 25`	(Optional) Sets the number of history buckets that are kept during the lifetime of an IP SLAs operation.
Step 6	**history distributions-of-statistics-kept** *size* **Example:** `Router(config-ip-sla-echo)# history distributions-of-statistics-kept 5`	(Optional) Sets the number of statistics distributions kept per hop during an IP SLAs operation.
Step 7	**history enhanced** [**interval** *seconds*] [**buckets** *number-of-buckets*] **Example:** `Router(config-ip-sla-echo)# history enhanced interval 900 buckets 100`	(Optional) Enables enhanced history gathering for an IP SLAs operation.

Step 8	**history filter** {**none** | **all** | **overThreshold** | **failures**}
	Example:
	`Router(config-ip-sla-echo)# history filter failures`
		(Optional) Defines the type of information kept in the history table for an IP SLAs operation.

Step 9	**frequency** *seconds* **Example:** `Router(config-ip-sla-echo)# frequency 30`	(Optional) Sets the rate at which a specified IP SLAs operation repeats.
Step 10	**history hours-of-statistics-kept** *hours* **Example:** `Router(config-ip-sla-echo)# history hours-of-statistics-kept 4`	(Optional) Sets the number of hours for which statistics are maintained for an IP SLAs operation.

	Command or Action	Purpose
Step 11	**history lives-kept** *lives* **Example:** `Router(config-ip-sla-echo)# history lives-kept 5`	(Optional) Sets the number of lives maintained in the history table for an IP SLAs operation.
Step 12	**owner** *owner-id* **Example:** `Router(config-ip-sla-echo)# owner admin`	(Optional) Configures the Simple Network Management Protocol (SNMP) owner of an IP SLAs operation.
Step 13	**request-data-size** *bytes* **Example:** `Router(config-ip-sla-echo)# request-data-size 64`	(Optional) Sets the protocol data size in the payload of an IP SLAs operation's request packet.
Step 14	**history statistics-distribution-interval** *milliseconds* **Example:** `Router(config-ip-sla-echo)# history statistics-distribution-interval 10`	(Optional) Sets the time interval for each statistics distribution kept for an IP SLAs operation.
Step 15	**tag** *text* **Example:** `Router(config-ip-sla-echo)# tag TelnetPollServer1`	(Optional) Creates a user-specified identifier for an IP SLAs operation.
Step 16	**threshold** *milliseconds* **Example:** `Router(config-ip-sla-echo)# threshold 10000`	(Optional) Sets the upper threshold value for calculating network monitoring statistics created by an IP SLAs operation.
Step 17	**timeout** *milliseconds* **Example:** `Router(config-ip-sla-echo)# timeout 10000`	(Optional) Sets the amount of time an IP SLAs operation waits for a response from its request packet.
Step 18	Do one of the following: • **tos** *number* • **traffic-class** *number* **Example:** `Router(config-ip-sla-jitter)# tos 160`	(Optional) In an IPv4 network only, defines the ToS byte in the IPv4 header of an IP SLAs operation. or (Optional) In an IPv6 network only, defines the traffic class byte in the IPv6 header for a supported IP SLAs operation.

	Command or Action	Purpose
	Example: `Router(config-ip-sla-jitter)# traffic-class 160`	
Step 19	**flow-label** *number* **Example:** `Router(config-ip-sla-echo)# flow-label 112233`	(Optional) In an IPv6 network only, defines the flow label field in the IPv6 header for a supported IP SLAs operation.
Step 20	**verify-data** **Example:** `Router(config-ip-sla-echo)# verify-data`	(Optional) Causes an IP SLAs operation to check each reply packet for data corruption.
Step 21	**vrf** *vrf-name* **Example:** `Router(config-ip-sla-echo)# vrf vpn-A`	(Optional) Allows monitoring within Multiprotocol Label Switching (MPLS) Virtual Private Networks (VPNs) using IP SLAs operations.

Step 22	**end**
	Example:
	`Router(config-ip-sla-echo)# end`
		Exits to privileged EXEC mode.

Scheduling IP SLAs Operations

Note

- All IP SLAs operations to be scheduled must be already configured.
- The frequency of all operations scheduled in a multioperation group must be the same.
- List of one or more operation ID numbers to be added to a multioperation group is limited to a maximum of 125 characters, including commas (,).

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. Do one of the following:
   - **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**]
   - **ip sla group schedule** *group-operation-number operation-id-numbers* **schedule-period** *schedule-period-range* [**ageout** *seconds*] [**frequency** *group-operation-frequency*] [**life**{**forever** | *seconds*}] [**start-time**{*hh:mm*[*:ss*] [*month day* | *day month*] | **pending** | **now** | **after** *hh:mm:ss*}]
4. **exit**
5. **show ip sla group schedule**
6. **show ip sla configuration**

DETAILED STEPS

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

Step 3	Do one of the following:
	• **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**]
	• **ip sla group schedule** *group-operation-number operation-id-numbers* **schedule-period** *schedule-period-range* [**ageout** *seconds*] [**frequency** *group-operation-frequency*] [**life**{**forever** | *seconds*}] [**start-time**{*hh:mm*[*:ss*] [*month day* | *day month*] | **pending** | **now** | **after** *hh:mm:ss*}]
	Example:
	`Router(config)# ip sla schedule 10 start-time now life forever`
	Example:
	`Router(config)# ip sla group schedule 1 3,4,6-9`
		For individual IP SLAs operations only:
		Configures the scheduling parameters for an individual IP SLAs operation.
		or
		For multioperation scheduler only:
		Specifies an IP SLAs operation group number and the range of operation numbers to be scheduled in global configuration mode.

Step 4	**exit**	Exits to privileged EXEC mode.

	Command or Action	Purpose
	Example: `Router(config)# exit`	
Step 5	**show ip sla group schedule** **Example:** `Router# show ip sla group schedule`	(Optional) Displays the IP SLAs group schedule details.
Step 6	**show ip sla configuration** **Example:** `Router# show ip sla configuration`	(Optional) Displays the IP SLAs configuration details.

- Troubleshooting Tips, page 16
- What to Do Next, page 16

Troubleshooting Tips

- If the IP SLAs operation is not running and generating statistics, add the **verify-data** command to the configuration of the operation (while configuring in IP SLA configuration mode) to enable data verification. When enabled, each operation response is checked for corruption. Use the **verify-data** command with caution during normal operations because it generates unnecessary overhead.
- Use the **debugipsla trace** and **debug ip sla error** commands to help troubleshoot issues with an IP SLAs operation.

What to Do Next

To add proactive threshold conditions and reactive triggering for generating traps, or for starting another operation, to an IP SLAs operation, see the "Configuring Proactive Threshold Monitoring" section.

To view and interpret the results of an IP SLAs operation use the **show ip sla statistics** command. Checking the output for fields that correspond to criteria in your service level agreement will help you determine whether the service metrics are acceptable.

Configuration Examples for IP SLAs ICMP Echo Operations

- Example Configuring an ICMP Echo Operation, page 139

Example Configuring an ICMP Echo Operation

The following example shows how to configure an IP SLAs operation type of ICMP Echo that will start immediately and run indefinitely.

```
ip sla 6
```

```
 icmp-echo 172.29.139.134 source-ip 172.29.139.132
 frequency 300
 request-data-size 28
 tos 160
 timeout 2000
 tag SFO-RO
ip sla schedule 6 life forever start-time now
```

Additional References

Related Documents

Related Topic	Document Title
Cisco IOS commands	Cisco IOS Master Commands List, All Releases
Cisco IOS IP SLAs commands	*Cisco IOS IP SLAs Command Reference*

Standards

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

MIBs

MIBs	MIBs Link
• CISCO-RTTMON-MIB • IPV6-FLOW-LABEL-MIB	To locate and download MIBs for selected platforms, Cisco IOS releases, and feature sets, use Cisco MIB Locator found at the following URL: http://www.cisco.com/go/mibs

RFCs

RFCs	Title
RFC 862	Echo Protocol

Technical Assistance

Description	Link
The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most	http://www.cisco.com/cisco/web/support/index.html

Description	Link
tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.	

Feature Information for IP SLAs ICMP Echo Operations

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 http://www.cisco.com/go/cfn. An account on Cisco.com is not required.

Table 17: Feature Information for IP SLAs ICMP Echo Operations

Feature Name	Releases	Feature Information
IP SLAs ICMP Echo Operation	Cisco IOS XE Release 2.1	The Cisco IOS XE IP SLAs Internet Control Message Protocol (ICMP) echo operation allows you to measure end-to-end network response time between a Cisco device and other devices using IP.
IP SLAs for IPv6 (UDP Jitter, UDP Echo, ICMP Echo, TCP Connect)	Cisco IOS XE Release 2.1	Support was added for operability in IPv6 networks.

Any Internet Protocol (IP) addresses and phone numbers used in this document are not intended to be actual addresses and phone numbers. Any examples, command display output, network topology diagrams, and other figures included in the document are shown for illustrative purposes only. Any use of actual IP addresses or phone numbers in illustrative content is unintentional and coincidental.

Configuring IP SLAs ICMP Path Echo Operations

This module describes how to configure an IP Service Level Agreements (SLAs) Internet Control Message Protocol (ICMP) Path Echo operation to monitor end-to-end and hop-by-hop response time between a Cisco router and devices using IP. ICMP Path Echo is useful for determining network availability and for troubleshooting network connectivity issues. The results of the ICMP Path Echo operation can be displayed and analyzed to determine how ICMP is performing.

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest feature information and caveats, see the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the Feature Information Table at the end of this document.

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

Restrictions for IP SLAs ICMP Path Echo Operations

We recommend using a Cisco networking device as the destination device although any networking device that supports RFC 862, Echo protocol, can be used.

Information About IP SLAs ICMP Path Echo Operations

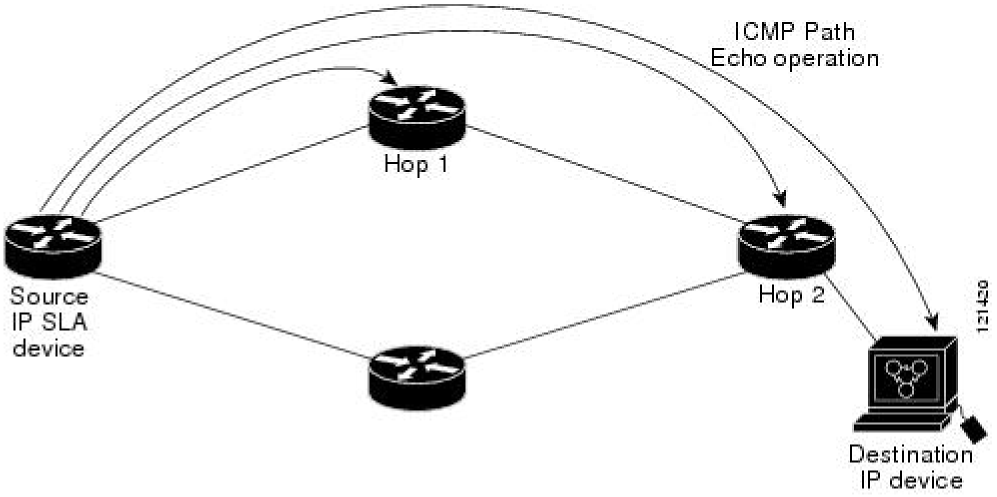
ICMP Path Echo Operation

To monitor ICMP Path Echo performance on a device, use the IP SLAs ICMP Path Echo operation. An ICMP Path Echo operation measures end-to-end and hop-by-hop response time between a Cisco router and devices using IP. ICMP Path Echo is useful for determining network availability and for troubleshooting network connectivity issues.

The IP SLAs ICMP Path Echo operation records statistics for each hop along the path that the IP SLAs operation takes to reach its destination. The ICMP Path Echo operation determines this hop-by-hop response time between a Cisco router and any IP device on the network by discovering the path using the traceroute facility.

In the figure below the source IP SLAs device uses traceroute to discover the path to the destination IP device. A ping is then used to measure the response time between the source IP SLAs device and each subsequent hop in the path to the destination IP device.

Figure 13: ICMP Path Echo Operation



Using the statistics recorded for the response times and availability, the ICMP Path Echo operation can identify a hop in the path that is causing a bottleneck.

How to Configure IP SLAs ICMP Path Echo Operations

Configuring an ICMP Path Echo Operation on the Source Device

Note This operation does not require an IP SLAs Responder on the destination device.

Perform only one of the following tasks:

- Configuring a Basic ICMP Path Echo Operation on the Source Device, page 145
- Configuring an ICMP Path Echo Operation with Optional Parameters on the Source Device, page 146

Configuring a Basic ICMP Path Echo Operation on the Source Device

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip sla** *operation-id*
4. **path-echo** {*destination-ip-address* | *destination-hostname*} [**source-ip** {*ip-address* | *hostname*}]
5. **frequency** *seconds*
6. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**ip sla** *operation-id* **Example:** `Router(config)# ip sla 7`	Specifies an ID number for the operation being configured, and enters IP SLA configuration mode.
Step 4	**path-echo** {*destination-ip-address* | *destination-hostname*} [**source-ip** {*ip-address* | *hostname*}] **Example:** `Router(config-ip-sla)# path-echo protocol 172.29.139.134`	Defines a Path Echo operation and enters IP SLA Path Echo configuration mode.
Step 5	**frequency** *seconds*	(Optional) Sets the rate at which a specified IP SLAs operation repeats.

	Command or Action	Purpose
	Example: `Router(config-ip-sla-pathEcho)# frequency 30`	

Step 6	**end**
	Example:
	`Router(config-ip-sla-pathEcho)# end`
		Exits to privileged EXEC mode.

Example

The following example shows the configuration of the IP SLAs ICMP Path Echo operation number 7 that will start in 30 seconds and run for 5 minutes.

```
ip sla 7
 path-echo 172.29.139.134
 frequency 30
!
ip sla schedule 7 start-time after 00:00:30 life 300
```

Configuring an ICMP Path Echo Operation with Optional Parameters on the Source Device

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip sla** *operation-number*
4. **path-echo** {*destination-ip-address* | *destination-hostname*} [**source-ip** {*ip-address* | *hostname*}]
5. **history buckets-kept** *size*
6. **history distributions-of-statistics-kept** *size*
7. **history enhanced** [**interval** *seconds*] [**buckets** *number-of-buckets*]
8. **history filter** {**none** | **all** | **overThreshold** | **failures**}
9. **frequency** *seconds*
10. **history hours-of-statistics-kept** *hours*
11. **history lives-kept** *lives*
12. **owner** *owner-id*
13. **paths-of-statistics-kept** *size*
14. **request-data-size** *bytes*
15. **samples-of-history-kept** *samples*
16. **history statistics-distribution-interval** *milliseconds*
17. **tag** *text*
18. **threshold** *milliseconds*
19. **timeout** *milliseconds*
20. **tos** *number*
21. **verify-data**
22. **vrf** *vrf-name*
23. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**ip sla** *operation-number* **Example:** `Router(config)# ip sla 10`	Begins configuration for an IP SLAs operation and enters IP SLA configuration mode.

	Command or Action	Purpose
Step 4	**path-echo** {*destination-ip-address* | *destination-hostname*} [**source-ip** {*ip-address* | *hostname*}] **Example:** `Router(config-ip-sla)# path-echo 172.29.139.134`	Defines a Path Echo operation and enters IP SLA Path Echo configuration mode.
Step 5	**history buckets-kept** *size* **Example:** `Router(config-ip-sla-pathEcho)# history buckets-kept 25`	(Optional) Sets the number of history buckets that are kept during the lifetime of an IP SLAs operation.
Step 6	**history distributions-of-statistics-kept** *size* **Example:** `Router(config-ip-sla-pathEcho)# history distributions-of-statistics-kept 5`	(Optional) Sets the number of statistics distributions kept per hop during an IP SLAs operation.
Step 7	**history enhanced** [**interval** *seconds*] [**buckets** *number-of-buckets*] **Example:** `Router(config-ip-sla-pathEcho)# history enhanced interval 900 buckets 100`	(Optional) Enables enhanced history gathering for an IP SLAs operation.

Step 8	**history filter** {**none** | **all** | **overThreshold** | **failures**}
	Example:
	`Router(config-ip-sla-pathEcho)# history filter failures`
		(Optional) Defines the type of information kept in the history table for an IP SLAs operation.

Step 9	**frequency** *seconds* **Example:** `Router(config-ip-sla-pathEcho)# frequency 30`	(Optional) Sets the rate at which a specified IP SLAs operation repeats.
Step 10	**history hours-of-statistics-kept** *hours* **Example:** `Router(config-ip-sla-pathEcho)# history hours-of-statistics-kept 4`	(Optional) Sets the number of hours for which statistics are maintained for an IP SLAs operation.
Step 11	**history lives-kept** *lives* **Example:** `Router(config-ip-sla-pathEcho)# history lives-kept 5`	(Optional) Sets the number of lives maintained in the history table for an IP SLAs operation.

	Command or Action	Purpose
Step 12	**owner** *owner-id* **Example:** `Router(config-ip-sla-pathEcho)# owner admin`	(Optional) Configures the Simple Network Management Protocol (SNMP) owner of an IP SLAs operation.
Step 13	**paths-of-statistics-kept** *size* **Example:** `Router(config-ip-sla-pathEcho)# paths-of-statistics-kept 3`	(Optional) Sets the number of paths for which statistics are maintained per hour for an IP SLAs operation.
Step 14	**request-data-size** *bytes* **Example:** `Router(config-ip-sla-pathEcho)# request-data-size 64`	(Optional) Sets the protocol data size in the payload of an IP SLAs operation's request packet.
Step 15	**samples-of-history-kept** *samples* **Example:** `Router(config-ip-sla-pathEcho)# samples-of-history-kept 10`	(Optional) Sets the number of entries kept in the history table per bucket for an IP SLAs operation.
Step 16	**history statistics-distribution-interval** *milliseconds* **Example:** `Router(config-ip-sla-pathEcho)# history statistics-distribution-interval 10`	(Optional) Sets the time interval for each statistics distribution kept for an IP SLAs operation.
Step 17	**tag** *text* **Example:** `Router(config-ip-sla-pathEcho)# tag TelnetPollServer1`	(Optional) Creates a user-specified identifier for an IP SLAs operation.
Step 18	**threshold** *milliseconds* **Example:** `Router(config-ip-sla-pathEcho)# threshold 10000`	(Optional) Sets the upper threshold value for calculating network monitoring statistics created by an IP SLAs operation.
Step 19	**timeout** *milliseconds* **Example:** `Router(config-ip-sla-pathEcho)# timeout 10000`	(Optional) Sets the amount of time an IP SLAs operation waits for a response from its request packet.
Step 20	**tos** *number*	(Optional) Defines a type of service (ToS) byte in the IP header of an IP SLAs operation.

	Command or Action	Purpose
	Example: `Router(config-ip-sla-pathEcho)# tos 160`	
Step 21	**verify-data** **Example:** `Router(config-ip-sla-pathEcho)# verify-data`	(Optional) Causes an IP SLAs operation to check each reply packet for data corruption.
Step 22	**vrf** *vrf-name* **Example:** `Router(config-ip-sla-pathEcho)# vrf vpn-A`	(Optional) Allows monitoring within Multiprotocol Label Switching (MPLS) Virtual Private Networks (VPNs) using IP SLAs operations.

Step 23	**end**
	Example:
	`Router(config-ip-sla-pathEcho)# end`
		Exits to privileged EXEC mode.

Scheduling IP SLAs Operations

Note

- All IP SLAs operations to be scheduled must be already configured.
- The frequency of all operations scheduled in a multioperation group must be the same.
- List of one or more operation ID numbers to be added to a multioperation group is limited to a maximum of 125 characters, including commas (,).

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. Do one of the following:
    - **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**]
    - **ip sla group schedule** *group-operation-number operation-id-numbers* **schedule-period** *schedule-period-range* [**ageout** *seconds*] [**frequency** *group-operation-frequency*] [**life**{**forever** | *seconds*}] [**start-time**{*hh:mm*[*:ss*] [*month day* | *day month*] | **pending** | **now** | **after** *hh:mm:ss*}]
4. **exit**
5. **show ip sla group schedule**
6. **show ip sla configuration**

DETAILED STEPS

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

Step 3	Do one of the following:
	• **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**]
	• **ip sla group schedule** *group-operation-number operation-id-numbers* **schedule-period** *schedule-period-range* [**ageout** *seconds*] [**frequency** *group-operation-frequency*] [**life**{**forever** | *seconds*}] [**start-time**{*hh:mm*[*:ss*] [*month day* | *day month*] | **pending** | **now** | **after** *hh:mm:ss*}]
	Example:
	`Router(config)# ip sla schedule 10 start-time now life forever`
	Example:
	`Router(config)# ip sla group schedule 1 3,4,6-9`
		For individual IP SLAs operations only:
		Configures the scheduling parameters for an individual IP SLAs operation.
		or
		For multioperation scheduler only:
		Specifies an IP SLAs operation group number and the range of operation numbers to be scheduled in global configuration mode.

Step 4	**exit** **Example:** `Router(config)# exit`	Exits to privileged EXEC mode.
Step 5	**show ip sla group schedule** **Example:** `Router# show ip sla group schedule`	(Optional) Displays the IP SLAs group schedule details.
Step 6	**show ip sla configuration** **Example:** `Router# show ip sla configuration`	(Optional) Displays the IP SLAs configuration details.

- Troubleshooting Tips, page 16
- What to Do Next, page 16

Troubleshooting Tips

- If the IP SLAs operation is not running and generating statistics, add the **verify-data** command to the configuration of the operation (while configuring in IP SLA configuration mode) to enable data verification. When enabled, each operation response is checked for corruption. Use the **verify-data** command with caution during normal operations because it generates unnecessary overhead.
- Use the **debugipsla trace** and **debug ip sla error** commands to help troubleshoot issues with an IP SLAs operation.

What to Do Next

To add proactive threshold conditions and reactive triggering for generating traps, or for starting another operation, to an IP SLAs operation, see the "Configuring Proactive Threshold Monitoring" section.

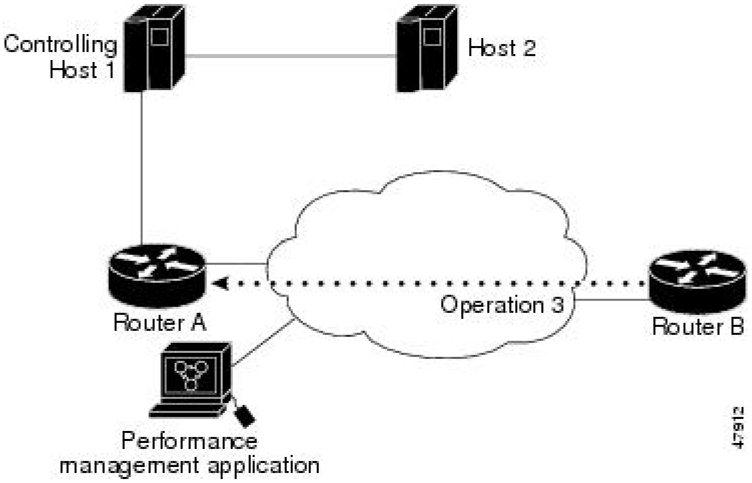
To view and interpret the results of an IP SLAs operation use the **show ip sla statistics** command. Checking the output for fields that correspond to criteria in your service level agreement will help you determine whether the service metrics are acceptable.

Configuration Examples for IP SLAs ICMP Path Echo Operations

Example Configuring an ICMP Path Echo Operation

The following example shows how to configure an IP SLAs operation type of ICMP Path Echo that will start after 30 seconds and run for 5 minutes. The figure below depicts the ICMP Path Echo operation.

Figure 14: ICMP Path Echo Operation



This example sets a Path Echo operation (ip sla 3) from Router B to Router A using IP/ICMP. The operation attempts to execute three times in 25 seconds (first attempt at 0 seconds).

Router B Configuration

```
ip sla 3
 path-echo 172.29.139.134
 frequency 10
 tag SGN-RO
 timeout 1000
ip sla schedule 3 life 25
```

Additional References

Related Documents

Related Topic	Document Title
Cisco IOS commands	Cisco IOS Master Commands List, All Releases
Cisco IOS IP SLAs commands	*Cisco IOS IP SLAs Command Reference*

Standards

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

MIBs

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

RFCs

RFCs	Title
RFC 862	Echo Protocol

Technical Assistance

Description	Link
The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.	http://www.cisco.com/cisco/web/support/index.html

Feature Information for IP SLAs ICMP Path Echo Operations

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 http://www.cisco.com/go/cfn. An account on Cisco.com is not required.

Table 18: Feature Information for the IP SLAs ICMP Path Echo Operation

Feature Name	Releases	Feature Information
IP SLAs ICMP Path Echo Operation	Cisco IOS XE Release 2.1	The IP SLAs Internet Control Message Protocol (ICMP) path echo operation allows you to measure end-to-end and hop-by-hop network response time between a Cisco device and other devices using IP.

Any Internet Protocol (IP) addresses and phone numbers used in this document are not intended to be actual addresses and phone numbers. Any examples, command display output, network topology diagrams, and other figures included in the document are shown for illustrative purposes only. Any use of actual IP addresses or phone numbers in illustrative content is unintentional and coincidental.

Configuring IP SLAs ICMP Path Jitter Operations

This document describes how to configure an IP Service Level Agreements (SLAs) Internet Control Message Protocol (ICMP) Path Jitter operation to monitor hop-by-hop jitter (inter-packet delay variance). This document also demonstrates how the data gathered using the Path Jitter operations can be displayed and analyzed using Cisco commands.

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest feature information and caveats, see the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the Feature Information Table at the end of this document.

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

Prerequisites for ICMP Path Jitter Operations

- Before configuring any IP SLAs application, you can use the **show ip sla application** command to verify that the operation type is supported on your software image.
- In contrast with other IP SLAs operations, the IP SLAs Responder does not have to be enabled on either the target device or intermediate devices for Path Jitter operations. However, the operational efficiency may improve if you enable the IP SLAs Responder.

Restrictions for ICMP Path Jitter Operations

- The IP SLAs ICMP Path Jitter operation is ICMP-based. ICMP-based operations can compensate for source processing delay but cannot compensate for target processing delay. For more robust monitoring and verifying, use of the IP SLAs UDP Jitter operation is recommended.
- The jitter values obtained using the ICMP Path Jitter operation are approximates because ICMP does not provide the capability to embed processing times on routers in the packet. If the target router does not place ICMP packets as the highest priority, then the router will not respond properly. ICMP performance also can be affected by the configuration of priority queueing on the router and by ping response.
- The path jitter operation does not support hourly statistics and hop information.
- Unlike other IP SLAs operations, the ICMP Path Jitter operation is not supported in the RTTMON MIB. Path Jitter operations can only be configured using Cisco commands and statistics can only be returned using the **show ip sla** commands.
- The IP SLAs Path Jitter operation does not support the IP SLAs History feature (statistics history buckets) because of the large data volume involved with Jitter operations.
- The following commands, available in Path Jitter configuration mode, do not apply to Path Jitter operations:
    - **history buckets-kept**
    - **history distributions-of-statistics-kept**
    - **history enhanced**
    - **history filter**
    - **history hours-of-statistics-kept**
    - **history lives-kept**
    - **history statistics-distribution-interval**
    - **samples-of-history-kept**
    - **lsr-path**
    - **tos**
    - **threshold**
    - **verify-data**

Information About IP SLAs ICMP Path Jitter Operations

- ICMP Path Jitter Operation, page 156

ICMP Path Jitter Operation

The IP SLAs ICMP Path Jitter operation provides hop-by-hop jitter, packet loss, and delay measurement statistics in an IP network. The Path Jitter operation functions differently than the standard UDP Jitter operation, which provides total one-way data and total round-trip data.

The ICMP Path Jitter operation can be used a supplement to the standard UDP Jitter operation. For example, results from the UDP Jitter operation may indicate unexpected delays or high jitter values; the ICMP Path Jitter operation could then be used to troubleshoot the network path and determine if traffic is bottlenecking in a particular segment along the transmission path.

The operation first discovers the hop-by-hop IP route from the source to the destination using a traceroute utility, and then uses ICMP echoes to determine the response times, packet loss and approximate jitter values for each hop along the path. The jitter values obtained using the ICMP Path Jitter operation are approximates because ICMP only provides round trip times.

The ICMP Path Jitter operation functions by tracing the IP path from a source device to a specified destination device, then sending *N* number of Echo probes to each hop along the traced path, with a time interval of *T* milliseconds between each Echo probe. The operation as a whole is repeated at a frequency of once every *F* seconds. The attributes are user-configurable, as shown here:

Path Jitter Operation Parameter	Default	Configured Using:
Number of echo probes (*N*)	10 echos	**path-jitter** command, **num-packets** option
Time between Echo probes, in milliseconds (*T*)	20 ms	**path-jitter** command, **interval** option **Note** The operation's frequency is different than the operation's interval.
The frequency of how often the operation is repeated (*F*)	once every 60 seconds	**frequency** command

How to Configure the IP SLAs ICMP Path Jitter Operation

- Configuring the IP SLAs Responder on a Destination Device, page 157
- Configuring an ICMP Path Jitter Operation on the Source Device, page 158
- Scheduling IP SLAs Operations, page 98

Configuring the IP SLAs Responder on a Destination Device

Note An IP SLAs Responder is not required on either the target device or intermediate devices for Path Jitter operations. However, operational efficiency may improve if you enable the IP SLAs Responder.

The networking device to be used as the responder must be a Cisco device and you must have connectivity to that device through the network.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip sla responder**
4. **exit**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**ip sla responder** **Example:** **Example:** `Router(config)# ip sla responder`	(Optional) Temporarily enables IP SLAs Responder functionality on a Cisco device in response to control messages from source. • Control is enabled by default.
Step 4	**exit** **Example:** `Router(config)# exit`	(Optional) Exits global configuration mode and returns to privileged EXEC mode.

Configuring an ICMP Path Jitter Operation on the Source Device

Perform only one of the following procedures in this section:

- Configuring a Basic ICMP Path Jitter Operation, page 158
- Configuring an ICMP Path Jitter Operation with Additional Parameters, page 159

Configuring a Basic ICMP Path Jitter Operation

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip sla** *operation-number*
4. **path-jitter** {*destination-ip-address* | *destination-hostname*} [**source-ip** {*ip-address* | *hostname*}] [**num-packets** *packet-number*] [**interval** *milliseconds*] [**targetOnly**]
5. **frequency** *seconds*
6. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**ip sla** *operation-number* **Example:** `Router(config)# ip sla 10`	Begins configuration for an IP SLAs operation and enters IP SLA configuration mode.
Step 4	**path-jitter** {*destination-ip-address* | *destination-hostname*} [**source-ip** {*ip-address* | *hostname*}] [**num-packets** *packet-number*] [**interval** *milliseconds*] [**targetOnly**] **Example:** `Router(config-ip-sla)# path-jitter 172.31.1.129 source-ip 10.2.30.1 num-packets 12 interval 22`	Defines an ICMP Path Jitter operation and enters IP SLA Path Jitter configuration mode.
Step 5	**frequency** *seconds* **Example:** `Router(config-ip-sla-pathJitter)# frequency 30`	(Optional) Sets the rate at which a specified IP SLAs operation repeats.

Step 6	**end**
	Example:
	`Router(config-ip-sla-pathJitter)# end`
		Exits to privileged EXEC mode.

Example

In the following example, the **targetOnly** keyword is used to bypass the hop-by-hop measurements. With this version of the command, echo probes will be sent to the destination only.

```
Router(config)# ip sla 1
Router(config-ip-sla)# path-jitter 172.17.246.20 num-packets 50 interval 30 targetOnly
```

Configuring an ICMP Path Jitter Operation with Additional Parameters

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip sla** *operation-number*
4. **path-jitter** {*destination-ip-address* | *destination-hostname*} [**source-ip** {*ip-address* | *hostname*}] [**num-packets** *packet-number*] [**interval** *milliseconds*] [**targetOnly**]
5. **frequency** *seconds*
6. **owner** *owner-id*
7. **request-data-size** *bytes*
8. **tag** *text*
9. **timeout** *milliseconds*
10. **vrf** *vrf-name*
11. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**ip sla** *operation-number* **Example:** `Router(config)# ip sla 10`	Begins configuration for an IP SLAs operation and enters IP SLA configuration mode.
Step 4	**path-jitter** {*destination-ip-address* | *destination-hostname*} [**source-ip** {*ip-address* | *hostname*}] [**num-packets** *packet-number*] [**interval** *milliseconds*] [**targetOnly**] **Example:** `Router(config-ip-sla)# path-jitter 172.31.1.129 source-ip 10.2.30.1 num-packets 12 interval 22`	Defines an ICMP Path Jitter operation and enters IP SLA Path Jitter configuration mode.
Step 5	**frequency** *seconds* **Example:** `Router(config-ip-sla-pathJitter)# frequency 30`	(Optional) Sets the rate at which a specified IP SLAs operation repeats.

	Command or Action	Purpose
Step 6	**owner** *owner-id* **Example:** `Router(config-ip-sla-pathJitter)# owner admin`	(Optional) Configures the Simple Network Management Protocol (SNMP) owner of an IP SLAs operation.
Step 7	**request-data-size** *bytes* **Example:** `Router(config-ip-sla-pathJitter)# request-data-size 64`	(Optional) Sets the protocol data size in the payload of an IP SLAs operation's request packet.
Step 8	**tag** *text* **Example:** `Router(config-ip-sla-pathJitter)# tag TelnetPollServer1`	(Optional) Creates a user-specified identifier for an IP SLAs operation.
Step 9	**timeout** *milliseconds* **Example:** `Router(config-ip-sla-pathJitter)# timeout 10000`	(Optional) Sets the amount of time an IP SLAs operation waits for a response from its request packet.
Step 10	**vrf** *vrf-name* **Example:** `Router(config-ip-sla-pathJitter)# vrf vpn-A`	(Optional) Allows monitoring within Multiprotocol Label Switching (MPLS) Virtual Private Networks (VPNs) using IP SLAs operations.

Step 11	**end**
	Example:
	`Router(config-ip-sla-pathJitter)# end`
		Exits to privileged EXEC mode.

Scheduling IP SLAs Operations

Note

- All IP SLAs operations to be scheduled must be already configured.
- The frequency of all operations scheduled in a multioperation group must be the same.
- List of one or more operation ID numbers to be added to a multioperation group is limited to a maximum of 125 characters, including commas (,).

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. Do one of the following:
    - **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**]
    - **ip sla group schedule** *group-operation-number operation-id-numbers* **schedule-period** *schedule-period-range* [**ageout** *seconds*] [**frequency** *group-operation-frequency*] [**life**{**forever** | *seconds*}] [**start-time**{*hh:mm*[*:ss*] [*month day* | *day month*] | **pending** | **now** | **after** *hh:mm:ss*}]
4. **exit**
5. **show ip sla group schedule**
6. **show ip sla configuration**

DETAILED STEPS

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

Step 3	Do one of the following:
	• **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**]
	• **ip sla group schedule** *group-operation-number operation-id-numbers* **schedule-period** *schedule-period-range* [**ageout** *seconds*] [**frequency** *group-operation-frequency*] [**life**{**forever** | *seconds*}] [**start-time**{*hh:mm*[*:ss*] [*month day* | *day month*] | **pending** | **now** | **after** *hh:mm:ss*}]
	Example:
	`Router(config)# ip sla schedule 10 start-time now life forever`
	Example:
	`Router(config)# ip sla group schedule 1 3,4,6-9`
		For individual IP SLAs operations only:
		Configures the scheduling parameters for an individual IP SLAs operation.
		or
		For multioperation scheduler only:
		Specifies an IP SLAs operation group number and the range of operation numbers to be scheduled in global configuration mode.

Step 4	**exit**	Exits to privileged EXEC mode.

	Command or Action	Purpose
	Example: `Router(config)# exit`	
Step 5	**show ip sla group schedule** **Example:** `Router# show ip sla group schedule`	(Optional) Displays the IP SLAs group schedule details.
Step 6	**show ip sla configuration** **Example:** `Router# show ip sla configuration`	(Optional) Displays the IP SLAs configuration details.

- Troubleshooting Tips, page 16
- What to Do Next, page 16

Troubleshooting Tips

- If the IP SLAs operation is not running and generating statistics, add the **verify-data** command to the configuration of the operation (while configuring in IP SLA configuration mode) to enable data verification. When enabled, each operation response is checked for corruption. Use the **verify-data** command with caution during normal operations because it generates unnecessary overhead.
- Use the **debugipsla trace** and **debug ip sla error** commands to help troubleshoot issues with an IP SLAs operation.

What to Do Next

To add proactive threshold conditions and reactive triggering for generating traps, or for starting another operation, to an IP SLAs operation, see the "Configuring Proactive Threshold Monitoring" section.

To view and interpret the results of an IP SLAs operation use the **show ip sla statistics** command. Checking the output for fields that correspond to criteria in your service level agreement will help you determine whether the service metrics are acceptable.

Configuration Examples for IP SLAs ICMP Path Jitter Operations

- Example Configuring a Path Jitter Operation, page 163

Example Configuring a Path Jitter Operation

The following example shows the output when the ICMP Path Jitter operation is configured. Because the path jitter operation does not support hourly statistics and hop information, the output for the **show ip sla statistics** command for the path jitter operation displays only the statistics for the first hop.

The following example shows the output when the ICMP Path Jitter operation is configured.

```
Router# configure terminal
Router(config)# ip sla 15011
Router(config-sla-monitor)# path-jitter 10.222.1.100 source-ip 10.222.3.100 num-packets 20
Router(config-sla-monitor-pathJitter)# frequency 30
Router(config-sla-monitor-pathJitter)# exit
Router(config)# ip sla schedule 15011 life forever start-time now
Router(config)# exit
Router# show ip sla statistics 15011
Round Trip Time (RTT) for       Index 15011
        Latest RTT: 1 milliseconds
Latest operation start time: 15:37:35.443 EDT Mon Jun 16 2008
Latest operation return code: OK
---- Path Jitter Statistics ----
Hop IP 10.222.3.252:
Round Trip Time milliseconds:
        Latest RTT: 1 ms
        Number of RTT: 20
        RTT Min/Avg/Max: 1/1/3 ms
Jitter time milliseconds:
        Number of jitter: 2
        Jitter Min/Avg/Max: 2/2/2 ms
Packet Values:
        Packet Loss (Timeouts): 0
        Out of Sequence: 0
        Discarded Samples: 0
Operation time to live: Forever
```

Additional References

Related Documents

Related Topic	Document Title
Cisco IOS commands	Cisco IOS Master Commands List, All Releases
Cisco IOS IP SLAs commands	*Cisco IOS IP SLAs Command Reference*

Standards

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

MIBs

MIBs	MIBs Link
MIB support for the Path Jitter operation is not provided.	To locate and download MIBs for selected platforms, Cisco IOS releases, and feature sets, use Cisco MIB Locator found at the following URL: http://www.cisco.com/go/mibs

RFCs

RFCs	Title
RFC 1889[4]	*RTP: A Transport Protocol for Real-Time Applications* ; see the section Estimating the Interarrival Jitter

Technical Assistance

Description	Link
The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.	http://www.cisco.com/cisco/web/support/index.html

Feature Information for IP SLAs ICMP Path Jitter Operations

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 http://www.cisco.com/go/cfn. An account on Cisco.com is not required.

Table 19: Feature Information for the IP SLAs ICMP Path Jitter Operation

Feature Name	Releases	Feature Information
IP SLAs Path Jitter Operation	Cisco IOS XE Release 2.1	The Cisco IOS XE IP SLAs Internet Control Message

[4] Support for the listed RFC is not claimed; listed as a reference only.

Feature Name	Releases	Feature Information
		Protocol (ICMP) path jitter operation allows you to measure hop-by-hop jitter (inter-packet delay variance).

Any Internet Protocol (IP) addresses and phone numbers used in this document are not intended to be actual addresses and phone numbers. Any examples, command display output, network topology diagrams, and other figures included in the document are shown for illustrative purposes only. Any use of actual IP addresses or phone numbers in illustrative content is unintentional and coincidental.

Configuring IP SLAs FTP Operations

This module describes how to configure an IP Service Level Agreements (SLAs) File Transfer Protocol (FTP) operation to measure the response time between a Cisco device and a FTP server to retrieve a file. The IP SLAs FTP operation supports an FTP GET request only. This module also demonstrates how the results of the FTP operation can be displayed and analyzed to determine the capacity of your network. The FTP operation can be used also for troubleshooting FTP server performance.

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest feature information and caveats, see the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the Feature Information Table at the end of this document.

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

Restrictions for IP SLAs FTP Operations

The IP SLAs FTP operation only supports FTP GET (download) requests.

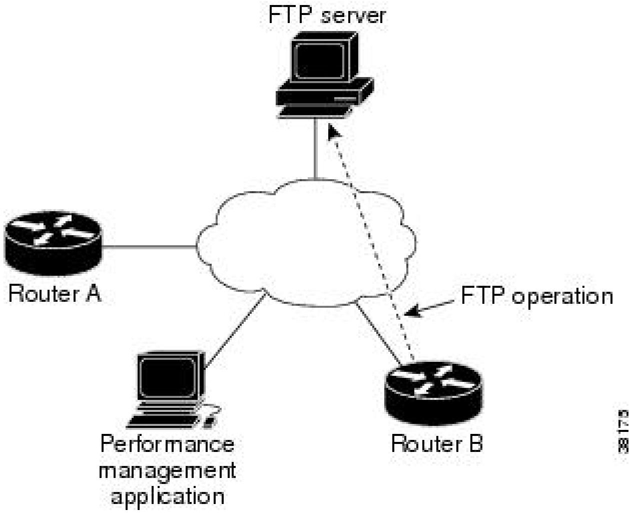
Information About IP SLAs FTP Operations

FTP Operation

The FTP operation measures the round-trip time (RTT) between a Cisco device and an FTP server to retrieve a file. FTP is an application protocol, part of the Transmission Control Protocol (TCP)/IP protocol stack, used for transferring files between network nodes.

In the figure below Router B is configured as the source IP SLAs device and an FTP operation is configured with the FTP server as the destination device.

Figure 15: FTP Operation



Connection response time is computed by measuring the time taken to download a file to Router B from the remote FTP server using FTP over TCP. This operation does not use the IP SLAs Responder.

Note To test the response time to connect to an FTP port (Port 21), use the IP SLAs TCP Connect operation.

Both active and passive FTP transfer modes are supported. The passive mode is enabled by default. Only the FTP GET (download) operation type is supported. The URL specified for the FTP GET operation must be in one of the following formats:

- ftp://username:password@host/filename
- ftp://host/filename

If the username and password are not specified, the defaults are anonymous and test, respectively.

FTP carries a significant amount of data traffic and can affect the performance of your network. The results of an IP SLAs FTP operation to retrieve a large file can be used to determine the capacity of the network but retrieve large files with caution because the FTP operation will consume more bandwidth. The FTP operation also measures your FTP server performance levels by determining the RTT taken to retrieve a file.

How to Configure IP SLAs FTP Operations

- Configuring an FTP Operation on a Source Device, page 169
- Scheduling IP SLAs Operations, page 98

Configuring an FTP Operation on a Source Device

Note There is no need to configure an IP SLAs responder on the destination device.

Perform one of the following tasks:

- Configuring a Basic FTP Operation on the Source Device, page 169
- Configuring an FTP Operation with Optional Parameters on the Source Device, page 170

Configuring a Basic FTP Operation on the Source Device

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip sla** *operation-number*
4. **ftp get** *url* [**source-ip** {*ip-address* | *hostname*}] [**mode** {**passive** | **active**}
5. **frequency** *seconds*
6. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**ip sla** *operation-number* **Example:** `Router(config)# ip sla 10`	Begins configuration for an IP SLAs operation and enters IP SLA configuration mode.
Step 4	**ftp get** *url* [**source-ip** {*ip-address* | *hostname*}] [**mode** {**passive** | **active**}	Defines an FTP operation and enters IP SLA FTP configuration mode.

	Command or Action	Purpose

	Example:
	`Router(config-ip-sla)# ftp get ftp://`
	`username:password@hostip/test.cap`	

Step 5	**frequency** *seconds* **Example:** `Router(config-ip-sla-ftp)# frequency 30`	(Optional) Sets the rate at which a specified IP SLAs operation repeats.

Step 6	**end**
	Example:
	`Router(config-ip-sla-ftp)# exit`
		Exits to privileged EXEC mode.

Configuring an FTP Operation with Optional Parameters on the Source Device

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip sla** *operation-number*
4. **ftp get** *url* [**source-ip** {*ip-address* | *hostname*}] [**mode** {**passive** | **active**}
5. **history buckets-kept** *size*
6. **history distributions-of-statistics-kept** *size*
7. **history enhanced** [**interval** *seconds*] [**buckets** *number-of-buckets*]
8. **history filter** {**none** | **all** | **overThreshold** | **failures**}
9. **frequency** *seconds*
10. **history hours-of-statistics-kept** *hours*
11. **history lives-kept** *lives*
12. **owner** *owner-id*
13. **history statistics-distribution-interval** *milliseconds*
14. **tag** *text*
15. **threshold** *milliseconds*
16. **timeout** *milliseconds*
17. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable**	Enables privileged EXEC mode.

	Command or Action	Purpose
	Example: `Router> enable`	• Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**ip sla** *operation-number* **Example:** `Router(config)# ip sla 10`	Begins configuration for an IP SLAs operation and enters IP SLA configuration mode.

Step 4	**ftp get** *url* [**source-ip** {*ip-address* | *hostname*}] [**mode** {**passive** | **active**}
	Example:
	`Router(config-ip-sla)# ftp get ftp://username:password@hostip/filename`
		Defines an FTP operation and enters IP SLA FTP configuration mode.

Step 5	**history buckets-kept** *size* **Example:** `Router(config-ip-sla-ftp)# history buckets-kept 25`	(Optional) Sets the number of history buckets that are kept during the lifetime of an IP SLAs operation.
Step 6	**history distributions-of-statistics-kept** *size* **Example:** `Router(config-ip-sla-ftp)# history distributions-of-statistics-kept 5`	(Optional) Sets the number of statistics distributions kept per hop during an IP SLAs operation.
Step 7	**history enhanced** [**interval** *seconds*] [**buckets** *number-of-buckets*] **Example:** `Router(config-ip-sla-ftp)# history enhanced interval 900 buckets 100`	(Optional) Enables enhanced history gathering for an IP SLAs operation.

Step 8	**history filter** {**none** | **all** | **overThreshold** | **failures**}
	Example:
	`Router(config-ip-sla-ftp)# history filter failures`
		(Optional) Defines the type of information kept in the history table for an IP SLAs operation.

Step 9	**frequency** *seconds*	(Optional) Sets the rate at which a specified IP SLAs operation repeats.

	Command or Action	Purpose
	Example: `Router(config-ip-sla-ftp)# frequency 30`	
Step 10	**history hours-of-statistics-kept** *hours* **Example:** `Router(config-ip-sla-ftp)# history hours-of-statistics-kept 4`	(Optional) Sets the number of hours for which statistics are maintained for an IP SLAs operation.
Step 11	**history lives-kept** *lives* **Example:** `Router(config-ip-sla-ftp)# history lives-kept 5`	(Optional) Sets the number of lives maintained in the history table for an IP SLAs operation.
Step 12	**owner** *owner-id* **Example:** `Router(config-ip-sla-ftp)# owner admin`	(Optional) Configures the Simple Network Management Protocol (SNMP) owner of an IP SLAs operation.
Step 13	**history statistics-distribution-interval** *milliseconds* **Example:** `Router(config-ip-sla-ftp)# history statistics-distribution-interval 10`	(Optional) Sets the time interval for each statistics distribution kept for an IP SLAs operation.
Step 14	**tag** *text* **Example:** `Router(config-ip-sla-ftp)# tag TelnetPollServer1`	(Optional) Creates a user-specified identifier for an IP SLAs operation.
Step 15	**threshold** *milliseconds* **Example:** `Router(config-ip-sla-ftp)# threshold 10000`	(Optional) Sets the upper threshold value for calculating network monitoring statistics created by an IP SLAs operation.
Step 16	**timeout** *milliseconds* **Example:** `Router(config-ip-sla-ftp)# timeout 10000`	(Optional) Sets the amount of time an IP SLAs operation waits for a response from its request packet.

Step 17	**end**
	Example:
	`Router(config-ip-sla-ftp)# end`
		Exits to privileged EXEC mode.

Scheduling IP SLAs Operations

Note

- All IP SLAs operations to be scheduled must be already configured.
- The frequency of all operations scheduled in a multioperation group must be the same.
- List of one or more operation ID numbers to be added to a multioperation group is limited to a maximum of 125 characters, including commas (,).

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. Do one of the following:
    - **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**]
    - **ip sla group schedule** *group-operation-number operation-id-numbers* **schedule-period** *schedule-period-range* [**ageout** *seconds*] [**frequency** *group-operation-frequency*] [**life**{**forever** | *seconds*}] [**start-time**{*hh:mm*[*:ss*] [*month day* | *day month*] | **pending** | **now** | **after** *hh:mm:ss*}]
4. **exit**
5. **show ip sla group schedule**
6. **show ip sla configuration**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	Do one of the following: • **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**] • **ip sla group schedule** *group-operation-number operation-id-numbers* **schedule-period** *schedule-period-range* [**ageout** *seconds*] [**frequency** *group-operation-frequency*] [**life**{**forever** | *seconds*}] [**start-**	For individual IP SLAs operations only: Configures the scheduling parameters for an individual IP SLAs operation. or For multioperation scheduler only: Specifies an IP SLAs operation group number and the range of operation numbers

	Command or Action	Purpose

	time{*hh:mm*[*:ss*] [*month day* | *day month*] | **pending** | **now** | **after** *hh:mm:ss*}]
	Example:
	`Router(config)# ip sla schedule 10 start-time now life forever`
	Example:
	`Router(config)# ip sla group schedule 1 3,4,6-9`
		to be scheduled in global configuration mode.

Step 4	**exit** **Example:** `Router(config)# exit`	Exits to privileged EXEC mode.
Step 5	**show ip sla group schedule** **Example:** `Router# show ip sla group schedule`	(Optional) Displays the IP SLAs group schedule details.
Step 6	**show ip sla configuration** **Example:** `Router# show ip sla configuration`	(Optional) Displays the IP SLAs configuration details.

- Troubleshooting Tips, page 16
- What to Do Next, page 16

Troubleshooting Tips

- If the IP SLAs operation is not running and generating statistics, add the **verify-data** command to the configuration of the operation (while configuring in IP SLA configuration mode) to enable data verification. When enabled, each operation response is checked for corruption. Use the **verify-data** command with caution during normal operations because it generates unnecessary overhead.
- Use the **debugipsla trace** and **debug ip sla error** commands to help troubleshoot issues with an IP SLAs operation.

What to Do Next

To add proactive threshold conditions and reactive triggering for generating traps, or for starting another operation, to an IP SLAs operation, see the "Configuring Proactive Threshold Monitoring" section.

To view and interpret the results of an IP SLAs operation use the **show ip sla statistics** command. Checking the output for fields that correspond to criteria in your service level agreement will help you determine whether the service metrics are acceptable.

Configuration Examples for IP SLAs FTP Operations

Example Configuring an FTP Operation

The following example shows how to configure an FTP operation from Router B to the FTP server as shown in the "FTP Operation" figure in the "Information About IP SLAs FTP Operation" section. The operation is scheduled to start every day at 1:30 a.m. In this example, the file named test.cap is to be retrieved from the host, cisco.com, with a password of abc using FTP in active mode.

Router B Configuration

```
ip sla 10
 ftp get ftp://user1:abc@test.cisco.com/test.cap mode active
 frequency 20
 tos 128
 timeout 40000
 tag FLL-FTP
ip sla schedule 10 start-time 01:30:00 recurring
```

Additional References

Related Documents

Related Topic	Document Title
Cisco IOS commands	Cisco IOS Master Commands List, All Releases
Cisco IOS IP SLAs commands	*Cisco IOS IP SLAs Command Reference*

Standards

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

MIBs

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

RFCs

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

Technical Assistance

Description	Link
The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.	http://www.cisco.com/cisco/web/support/index.html

Feature Information for IP SLAs FTP Operations

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 http://www.cisco.com/go/cfn. An account on Cisco.com is not required.

Table 20: Feature Information for the IP SLAs FTP Operation

Feature Name	Releases	Feature Information
IP SLAs FTP Operation	Cisco IOS XE Release 2.1	The P SLAs File Transfer Protocol (FTP) operation allows you to measure the network response time between a Cisco device and an FTP server to retrieve a file.

Any Internet Protocol (IP) addresses and phone numbers used in this document are not intended to be actual addresses and phone numbers. Any examples, command display output, network topology diagrams, and other figures included in the document are shown for illustrative purposes only. Any use of actual IP addresses or phone numbers in illustrative content is unintentional and coincidental.

Configuring IP SLAs DNS Operations

This module describes how to configure the IP Service Level Agreements (SLAs) Domain Name System (DNS) operation to measure the difference between the time taken to send a DNS request and receive a reply. This module also demonstrates how the results of the DNS operation can be displayed and analyzed to determine the DNS lookup time which is a critical element for determining the performance of a DNS or web server.

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest feature information and caveats, see the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the Feature Information Table at the end of this document.

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

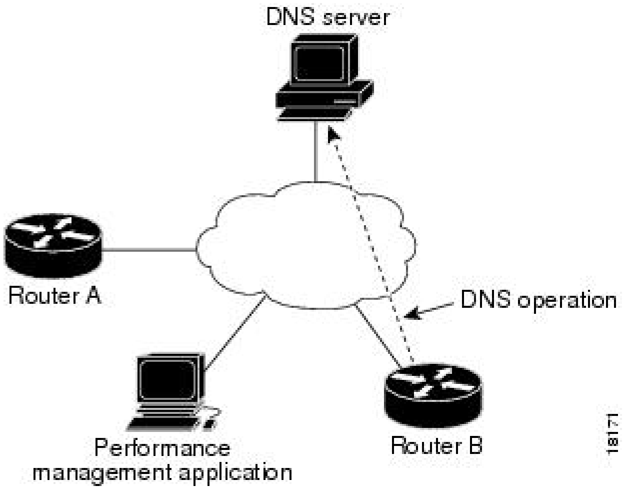
Information About IP SLAs DNS Operations

DNS Operation

The DNS operation measures the difference between the time taken to send a DNS request and receive a reply. DNS is used in the Internet for translating names of network nodes into addresses. The IP SLAs DNS operation queries for an IP address if you specify a host name, or queries for a host name if you specify an IP address.

In the figure below Router B is configured as the source IP SLAs device and a DNS operation is configured with the DNS server as the destination device.

Figure 16: DNS Operation



Connection response time is computed by measuring the difference between the time taken to send a request to the DNS server and the time a reply is received by Router B. The resulting DNS lookup time can help you analyze your DNS performance. Faster DNS lookup times translate to a faster web server access experience.

How to Configure IP SLAs DNS Operations

- Configuring an IP SLAs DNS Operation on the Source Device, page 180
- Scheduling IP SLAs Operations, page 98

Configuring an IP SLAs DNS Operation on the Source Device

Note There is no need to configure an IP SLAs responder on the destination device.

Perform one of the following tasks:

- Configuring a Basic DNS Operation on the Source Device, page 180
- Configuring a DNS Operation with Optional Parameters on the Source Device, page 182

Configuring a Basic DNS Operation on the Source Device

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip sla** *operation-number*
4. **dns** {*destination-ip-address* | *destination-hostname*} **name-server** *ip-address* [**source-ip** {*ip-address* | *hostname*} **source-port** *port-number*]
5. **frequency** *seconds*
6. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**ip sla** *operation-number* **Example:** `Router(config)# ip sla 10`	Begins configuration for an IP SLAs operation and enters IP SLA configuration mode.
Step 4	**dns** {*destination-ip-address* | *destination-hostname*} **name-server** *ip-address* [**source-ip** {*ip-address* | *hostname*} **source-port** *port-number*] **Example:** `Router(config-ip-sla)# dns host1 name-server 172.20.2.132`	Defines a DNS operation and enters IP SLA DNS configuration mode.
Step 5	**frequency** *seconds* **Example:** `Router(config-ip-sla-dns)# frequency 60`	(Optional) Sets the rate at which a specified IP SLAs operation repeats.

Step 6	**end**
	Example:
	`Router(config-ip-sla-dns)# end`
		Exits to privileged EXEC mode.

Configuring a DNS Operation with Optional Parameters on the Source Device

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip sla** *operation-number*
4. **dns** {*destination-ip-address* | *destination-hostname*} **name-server** *ip-address* [**source-ip** {*ip-address* | *hostname*} **source-port** *port-number*]
5. **history buckets-kept** *size*
6. **history distributions-of-statistics-kept** *size*
7. **history enhanced** [**interval** *seconds*] [**buckets** *number-of-buckets*]
8. **history filter** {**none** | **all** | **overThreshold** | **failures**}
9. **frequency** *seconds*
10. **history hours-of-statistics-kept** *hours*
11. **history lives-kept** *lives*
12. **owner** *owner-id*
13. **history statistics-distribution-interval** *milliseconds*
14. **tag** *text*
15. **threshold** *milliseconds*
16. **timeout** *milliseconds*
17. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**ip sla** *operation-number* **Example:** `Router(config)# ip sla 10`	Begins configuration for an IP SLAs operation and enters IP SLA configuration mode.
Step 4	**dns** {*destination-ip-address* | *destination-hostname*} **name-server** *ip-address* [**source-ip** {*ip-address* | *hostname*} **source-port** *port-number*]	Defines a DNS operation and enters IP SLA DNS configuration mode.

	Command or Action	Purpose
	Example: `Router(config-ip-sla)# dns host1 name-server 172.20.2.132`	
Step 5	**history buckets-kept** *size* **Example:** `Router(config-ip-sla-dns)# history buckets-kept 25`	(Optional) Sets the number of history buckets that are kept during the lifetime of an IP SLAs operation.
Step 6	**history distributions-of-statistics-kept** *size* **Example:** `Router(config-ip-sla-dns)# history distributions-of-statistics-kept 5`	(Optional) Sets the number of statistics distributions kept per hop during an IP SLAs operation.
Step 7	**history enhanced** [**interval** *seconds*] [**buckets** *number-of-buckets*] **Example:** `Router(config-ip-sla-dns)# history enhanced interval 900 buckets 100`	(Optional) Enables enhanced history gathering for an IP SLAs operation.

Step 8	**history filter** {**none** | **all** | **overThreshold** | **failures**}
	Example:
	`Router(config-ip-sla-dns)# history filter failures`
		(Optional) Defines the type of information kept in the history table for an IP SLAs operation.

Step 9	**frequency** *seconds* **Example:** `Router(config-ip-sla-dns)# frequency 30`	(Optional) Sets the rate at which a specified IP SLAs operation repeats.
Step 10	**history hours-of-statistics-kept** *hours* **Example:** `Router(config-ip-sla-dns)# history hours-of-statistics-kept 4`	(Optional) Sets the number of hours for which statistics are maintained for an IP SLAs operation.
Step 11	**history lives-kept** *lives* **Example:** `Router(config-ip-sla-dns)# history lives-kept 5`	(Optional) Sets the number of lives maintained in the history table for an IP SLAs operation.
Step 12	**owner** *owner-id*	(Optional) Configures the Simple Network Management Protocol (SNMP) owner of an IP SLAs operation.

	Command or Action	Purpose
	Example: `Router(config-ip-sla-dns)# owner admin`	
Step 13	**history statistics-distribution-interval** *milliseconds* **Example:** `Router(config-ip-sla-dns)# history statistics-distribution-interval 10`	(Optional) Sets the time interval for each statistics distribution kept for an IP SLAs operation.
Step 14	**tag** *text* **Example:** `Router(config-ip-sla-dns)# tag TelnetPollServer1`	(Optional) Creates a user-specified identifier for an IP SLAs operation.
Step 15	**threshold** *milliseconds* **Example:** `Router(config-ip-sla-dns)# threshold 10000`	(Optional) Sets the upper threshold value for calculating network monitoring statistics created by an IP SLAs operation.
Step 16	**timeout** *milliseconds* **Example:** `Router(config-ip-sla-dns)# timeout 10000`	(Optional) Sets the amount of time an IP SLAs operation waits for a response from its request packet.

Step 17	**end**
	Example:
	`Router(config-ip-sla-dns)# end`
		Exits to privileged EXEC mode.

Scheduling IP SLAs Operations

Note

- All IP SLAs operations to be scheduled must be already configured.
- The frequency of all operations scheduled in a multioperation group must be the same.
- List of one or more operation ID numbers to be added to a multioperation group is limited to a maximum of 125 characters, including commas (,).

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. Do one of the following:
   - **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**]
   - **ip sla group schedule** *group-operation-number operation-id-numbers* **schedule-period** *schedule-period-range* [**ageout** *seconds*] [**frequency** *group-operation-frequency*] [**life**{**forever** | *seconds*}] [**start-time**{*hh:mm*[*:ss*] [*month day* | *day month*] | **pending** | **now** | **after** *hh:mm:ss*}]
4. **exit**
5. **show ip sla group schedule**
6. **show ip sla configuration**

DETAILED STEPS

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

Step 3	Do one of the following:
	• **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**]
	• **ip sla group schedule** *group-operation-number operation-id-numbers* **schedule-period** *schedule-period-range* [**ageout** *seconds*] [**frequency** *group-operation-frequency*] [**life**{**forever** | *seconds*}] [**start-time**{*hh:mm*[*:ss*] [*month day* | *day month*] | **pending** | **now** | **after** *hh:mm:ss*}]
	Example:
	`Router(config)# ip sla schedule 10 start-time now life forever`
	Example:
	`Router(config)# ip sla group schedule 1 3,4,6-9`
		For individual IP SLAs operations only:
		Configures the scheduling parameters for an individual IP SLAs operation.
		or
		For multioperation scheduler only:
		Specifies an IP SLAs operation group number and the range of operation numbers to be scheduled in global configuration mode.

Step 4	**exit**	Exits to privileged EXEC mode.

	Command or Action	Purpose
	Example: `Router(config)# exit`	
Step 5	**show ip sla group schedule** **Example:** `Router# show ip sla group schedule`	(Optional) Displays the IP SLAs group schedule details.
Step 6	**show ip sla configuration** **Example:** `Router# show ip sla configuration`	(Optional) Displays the IP SLAs configuration details.

- Troubleshooting Tips, page 16
- What to Do Next, page 16

Troubleshooting Tips

- If the IP SLAs operation is not running and generating statistics, add the **verify-data** command to the configuration of the operation (while configuring in IP SLA configuration mode) to enable data verification. When enabled, each operation response is checked for corruption. Use the **verify-data** command with caution during normal operations because it generates unnecessary overhead.
- Use the **debugipsla trace** and **debug ip sla error** commands to help troubleshoot issues with an IP SLAs operation.

What to Do Next

To add proactive threshold conditions and reactive triggering for generating traps, or for starting another operation, to an IP SLAs operation, see the "Configuring Proactive Threshold Monitoring" section.

To view and interpret the results of an IP SLAs operation use the **show ip sla statistics** command. Checking the output for fields that correspond to criteria in your service level agreement will help you determine whether the service metrics are acceptable.

Configuration Examples for IP SLAs DNS Operations

- Example Configuring a DNS Operation, page 186

Example Configuring a DNS Operation

The following example shows how to configure a DNS operation from Router B to the DNS server (IP address 172.20.2.132) as shown in the "DNS Operation" figure in the "DNS peration" section. The operation is scheduled to start immediately. In this example, the target address is a hostname and the DNS operation will query the DNS server for the IP address associated with the hostname host1. No configuration is required at the DNS server.

Router B Configuration

```
ip sla 11
 dns host1 name-server 172.20.2.132
 frequency 50
 timeout 8000
 tag DNS-Test
ip sla schedule 11 start-time now
```

Additional References

Related Documents

Related Topic	Document Title
Cisco IOS commands	Cisco IOS Master Commands List, All Releases
Cisco IOS IP SLAs commands	*Cisco IOS IP SLAs Command Reference*

Standards

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

MIBs

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

RFCs

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

Technical Assistance

Description	Link
The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.	http://www.cisco.com/cisco/web/support/index.html

Feature Information for IP SLAs DNS Operations

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 http://www.cisco.com/go/cfn. An account on Cisco.com is not required.

Table 21: Feature Information for the IP SLAs DNS Operation

Feature Name	Releases	Feature Information
IP SLAs DNS Operation	Cisco IOS XE Release 2.1	The IP SLAs Domain Name System (DNS) operation allows you to measure the difference between the time taken to send a DNS request and receive a reply.

Any Internet Protocol (IP) addresses and phone numbers used in this document are not intended to be actual addresses and phone numbers. Any examples, command display output, network topology diagrams, and other figures included in the document are shown for illustrative purposes only. Any use of actual IP addresses or phone numbers in illustrative content is unintentional and coincidental.

Configuring IP SLAs DHCP Operations

This module describes how to configure an IP Service Level Agreements (SLAs) Dynamic Host Control Protocol (DHCP) operation to measure the response time between a Cisco device and a DHCP server to obtain an IP address.

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest feature information and caveats, see the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the Feature Information Table at the end of this document.

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

Information About IP SLAs DHCP Operations

DHCP Operation

DHCP provides a mechanism for allocating IP addresses dynamically so that addresses can be reused when hosts no longer need them. The DHCP operation measures the round-trip time (RTT) taken to discover a DHCP server and obtain a leased IP address from it. IP SLAs releases the leased IP address after the operation.

You can use the RTT information to determine DHCP performance levels.

There are two modes for the DHCP operation. By default, the DHCP operation sends discovery packets on every available IP interface on the router. If a specific server is configured on the router, discovery packets are sent only to the specified DHCP server.

IP SLAs DHCP Relay Agent Options

A DHCP relay agent is any host that forwards DHCP packets between clients and servers. Relay agents are used to forward requests and replies between clients and servers when they are not on the same physical subnet. Relay agent forwarding is distinct from the normal forwarding of an IP router, where IP packets are switched between networks somewhat transparently. Relay agents receive DHCP messages and then generate a new DHCP message to send out on another interface.

The IP SLAs DHCP operation contains a relay agent information option--Option 82--which is inserted by the DHCP relay agent when forwarding client-originated DHCP packets to a DHCP server. Servers recognizing the relay agent information option may use the information to implement IP address or other parameter assignment policies. The DHCP server echoes the option back verbatim to the relay agent in server-to-client replies, and the relay agent strips the option before forwarding the reply to the client.

Option 82 includes three suboptions that convey information known by the relay agent:

- **circuit-id** --identifies the incoming circuit.
- **remote-id** --provides a trusted identifier for a remote high-speed modem.
- **subnet-mask** --identifies the mask of the logical IP subnet from which the relay agent received the client DHCP packet.

How to Configure IP SLAs DHCP Operations

Note There is no need to configure an IP SLAs responder on the destination device.

- Configuring a DHCP Operation on the Source Device, page 190
- Scheduling IP SLAs Operations, page 98

Configuring a DHCP Operation on the Source Device

Perform one of the following tasks:

- Configuring a Basic DHCP Operation, page 190
- Configuring a DHCP Operation with Optional Parameters, page 192

Configuring a Basic DHCP Operation

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip sla** *operation-number*
4. **dhcp** {*destination-ip-address* | *destination-hostname*} [**source-ip** {*ip-address* | *hostname*}] [**option-82** [**circuit-id** *circuit-id*] [**remote-id** *remote-id*] [**subnet-mask** *subnet-mask*]]
5. **frequency** *seconds*
6. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**ip sla** *operation-number* **Example:** `Router(config)# ip sla 10`	Begins configuration for an IP SLAs operation and enters IP SLA configuration mode.
Step 4	**dhcp** {*destination-ip-address* | *destination-hostname*} [**source-ip** {*ip-address* | *hostname*}] [**option-82** [**circuit-id** *circuit-id*] [**remote-id** *remote-id*] [**subnet-mask** *subnet-mask*]] **Example:** `Router(config-ip-sla)# dhcp 10.10.10.3`	Defines a DHCP operation and enters IP SLA DHCP configuration mode.
Step 5	**frequency** *seconds* **Example:** `Router(config-ip-sla-dhcp)# frequency 30`	(Optional) Sets the rate at which a specified IP SLAs operation repeats.

Step 6	**end**
	Example:
	`Router(config-ip-sla-dhcp)# end`
		Exits to privileged EXEC mode.

Configuring a DHCP Operation with Optional Parameters

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip sla** *operation-number*
4. **dhcp** {*destination-ip-address* | *destination-hostname*} [**source-ip** {*ip-address* | *hostname*}] [**option-82** [**circuit-id** *circuit-id*] [**remote-id** *remote-id*] [**subnet-mask** *subnet-mask*]]
5. **history buckets-kept** *size*
6. **history distributions-of-statistics-kept** *size*
7. **history enhanced** [**interval** *seconds*] [**buckets** *number-of-buckets*]
8. **history filter** {**none** | **all** | **overThreshold** | **failures**}
9. **frequency** *seconds*
10. **history hours-of-statistics-kept** *hours*
11. **history lives-kept** *lives*
12. **owner** *owner-id*
13. **history statistics-distribution-interval** *milliseconds*
14. **tag** *text*
15. **threshold** *milliseconds*
16. **timeout** *milliseconds*
17. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**ip sla** *operation-number* **Example:** `Router(config)# ip sla 10`	Begins configuration for an IP SLAs operation and enters IP SLA configuration mode.
Step 4	**dhcp** {*destination-ip-address* | *destination-hostname*} [**source-ip** {*ip-address* | *hostname*}] [**option-82** [**circuit-id** *circuit-id*] [**remote-id** *remote-id*] [**subnet-mask** *subnet-mask*]]	Defines a DHCP operation and enters IP SLA DHCP configuration mode.

	Command or Action	Purpose
	Example: `Router(config-ip-sla)# dhcp 10.10.10.3 option-82 circuit-id 10005A6F1234`	
Step 5	**history buckets-kept** *size* **Example:** `Router(config-ip-sla-dhcp)# history buckets-kept 25`	(Optional) Sets the number of history buckets that are kept during the lifetime of an IP SLAs operation.
Step 6	**history distributions-of-statistics-kept** *size* **Example:** `Router(config-ip-sla-dhcp)# history distributions-of-statistics-kept 5`	(Optional) Sets the number of statistics distributions kept per hop during an IP SLAs operation.
Step 7	**history enhanced** [**interval** *seconds*] [**buckets** *number-of-buckets*] **Example:** `Router(config-ip-sla-dhcp)# history enhanced interval 900 buckets 100`	(Optional) Enables enhanced history gathering for an IP SLAs operation.

Step 8	**history filter** {**none** | **all** | **overThreshold** | **failures**}
	Example:
	`Router(config-ip-sla-dhcp)# history filter failures`
		(Optional) Defines the type of information kept in the history table for an IP SLAs operation.

Step 9	**frequency** *seconds* **Example:** `Router(config-ip-sla-dhcp)# frequency 30`	(Optional) Sets the rate at which a specified IP SLAs operation repeats.
Step 10	**history hours-of-statistics-kept** *hours* **Example:** `Router(config-ip-sla-dhcp)# history hours-of-statistics-kept 4`	(Optional) Sets the number of hours for which statistics are maintained for an IP SLAs operation.
Step 11	**history lives-kept** *lives* **Example:** `Router(config-ip-sla-dhcp)# history lives-kept 5`	(Optional) Sets the number of lives maintained in the history table for an IP SLAs operation.
Step 12	**owner** *owner-id*	(Optional) Configures the Simple Network Management Protocol (SNMP) owner of an IP SLAs operation.

	Command or Action	Purpose
	Example: `Router(config-ip-sla-dhcp)# owner admin`	
Step 13	**history statistics-distribution-interval** *milliseconds* **Example:** `Router(config-ip-sla-dhcp)# history statistics-distribution-interval 10`	(Optional) Sets the time interval for each statistics distribution kept for an IP SLAs operation.
Step 14	**tag** *text* **Example:** `Router(config-ip-sla-dhcp)# tag TelnetPollServer1`	(Optional) Creates a user-specified identifier for an IP SLAs operation.
Step 15	**threshold** *milliseconds* **Example:** `Router(config-ip-sla-dhcp)# threshold 10000`	(Optional) Sets the upper threshold value for calculating network monitoring statistics created by an IP SLAs operation.
Step 16	**timeout** *milliseconds* **Example:** `Router(config-ip-sla-dhcp)# timeout 10000`	(Optional) Sets the amount of time an IP SLAs operation waits for a response from its request packet.

Step 17	**end**
	Example:
	`Router(config-ip-sla-dhcp)# end`
		Exits to privileged EXEC mode.

Scheduling IP SLAs Operations

Note

- All IP SLAs operations to be scheduled must be already configured.
- The frequency of all operations scheduled in a multioperation group must be the same.
- List of one or more operation ID numbers to be added to a multioperation group is limited to a maximum of 125 characters, including commas (,).

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. Do one of the following:
   - **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**]
   - **ip sla group schedule** *group-operation-number operation-id-numbers* **schedule-period** *schedule-period-range* [**ageout** *seconds*] [**frequency** *group-operation-frequency*] [**life**{**forever** | *seconds*}] [**start-time**{*hh:mm*[*:ss*] [*month day* | *day month*] | **pending** | **now** | **after** *hh:mm:ss*}]
4. **exit**
5. **show ip sla group schedule**
6. **show ip sla configuration**

DETAILED STEPS

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

Step 3	Do one of the following:
	• **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**]
	• **ip sla group schedule** *group-operation-number operation-id-numbers* **schedule-period** *schedule-period-range* [**ageout** *seconds*] [**frequency** *group-operation-frequency*] [**life**{**forever** | *seconds*}] [**start-time**{*hh:mm*[*:ss*] [*month day* | *day month*] | **pending** | **now** | **after** *hh:mm:ss*}]
	Example:
	`Router(config)# ip sla schedule 10 start-time now life forever`
	Example:
	`Router(config)# ip sla group schedule 1 3,4,6-9`
		For individual IP SLAs operations only:
		Configures the scheduling parameters for an individual IP SLAs operation.
		or
		For multioperation scheduler only:
		Specifies an IP SLAs operation group number and the range of operation numbers to be scheduled in global configuration mode.

Step 4	**exit**	Exits to privileged EXEC mode.

	Command or Action	Purpose
	Example: `Router(config)# exit`	
Step 5	**show ip sla group schedule** **Example:** `Router# show ip sla group schedule`	(Optional) Displays the IP SLAs group schedule details.
Step 6	**show ip sla configuration** **Example:** `Router# show ip sla configuration`	(Optional) Displays the IP SLAs configuration details.

- Troubleshooting Tips, page 16
- What to Do Next, page 16

Troubleshooting Tips

- If the IP SLAs operation is not running and generating statistics, add the **verify-data** command to the configuration of the operation (while configuring in IP SLA configuration mode) to enable data verification. When enabled, each operation response is checked for corruption. Use the **verify-data** command with caution during normal operations because it generates unnecessary overhead.
- Use the **debugipsla trace** and **debug ip sla error** commands to help troubleshoot issues with an IP SLAs operation.

What to Do Next

To add proactive threshold conditions and reactive triggering for generating traps, or for starting another operation, to an IP SLAs operation, see the "Configuring Proactive Threshold Monitoring" section.

To view and interpret the results of an IP SLAs operation use the **show ip sla statistics** command. Checking the output for fields that correspond to criteria in your service level agreement will help you determine whether the service metrics are acceptable.

Configuration Examples for IP SLAs DHCP Operations

- Example Configuration for an IP SLAs DHCP Operation, page 196

Example Configuration for an IP SLAs DHCP Operation

In the following example, IP SLAs operation number 12 is configured as a DHCP operation enabled for DHCP server 172.16.20.3. Note that DHCP option 82 is used to specify the circuit ID.

Router B Configuration

```
ip dhcp-server 172.16.20.3
!
ip sla 12
 dhcp 10.10.10.3 option-82 circuit-id 10005A6F1234
 frequency 30
 timeout 5000
 tag DHCP_Test
!
ip sla schedule 12 start-time now
```

Additional References

Related Documents

Related Topic	Document Title
Cisco IOS commands	Cisco IOS Master Commands List, All Releases
Cisco IOS IP SLAs commands	*Cisco IOS IP SLAs Command Reference*

Standards

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

MIBs

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

RFCs

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

Technical Assistance

Description	Link
The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.	http://www.cisco.com/cisco/web/support/index.html

Feature Information for IP SLAs DHCP Operations

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 http://www.cisco.com/go/cfn. An account on Cisco.com is not required.

Table 22: Feature Information for the IP SLAs DHCP Operation

Feature Name	Releases	Feature Information
IP SLAs DHCP Operation	Cisco IOS XE Release 2.1	The IP SLAs Dynamic Host Control Protocol (DHCP) operation allows you to schedule and measure the network response time between a Cisco device and a DHCP server to obtain an IP address.

Any Internet Protocol (IP) addresses and phone numbers used in this document are not intended to be actual addresses and phone numbers. Any examples, command display output, network topology diagrams, and other figures included in the document are shown for illustrative purposes only. Any use of actual IP addresses or phone numbers in illustrative content is unintentional and coincidental.

Configuring an IP SLAs Multioperation Scheduler

This document describes how to schedule multiple operations at once using the IP Service Level Agreements (SLAs) Multioperations Scheduler feature.

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest feature information and caveats, see the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the Feature Information Table at the end of this document.

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

Prerequisites for an IP SLAs Multioperation Scheduler

- Configure the IP SLAs operations to be included in a group before scheduling the group.
- Determine the IP SLAs operations you want to schedule as a single group.
- Identify the network traffic type and the location of your network management station.
- Identify the topology and the types of devices in your network.
- Decide on the frequency of testing for each operation.

Information About an IP SLAs Multioperation Scheduler

IP SLAs Multioperations Scheduler

Normal scheduling of IP SLAs operations allows you to schedule one operation at a time. If you have large networks with thousands of IP SLAs operations to monitor network performance, normal scheduling (scheduling each operation individually) will be inefficient and time-consuming.

Multiple operations scheduling allows you to schedule multiple IP SLAs operations using a single command through the command line interface (CLI) or the CISCO-RTTMON-MIB. This feature allows you to control the amount of IP SLAs monitoring traffic by scheduling the operations to run at evenly distributed times. You must specify the operation ID numbers to be scheduled and the time range over which all the IP SLAs operations should start. This feature automatically distributes the IP SLAs operations at equal intervals over a specified time frame. The spacing between the operations (start interval) is calculated and the operations are started. This distribution of IP SLAs operations helps minimize the CPU utilization and thereby enhances the scalability of the network.

The IP SLAs multiple operations scheduling functionality allows you to schedule multiple IP SLAs operations as a group, using the following configuration parameters:

- Group operation number--Group configuration or group schedule number of the IP SLAs operation to be scheduled.
- Operation ID numbers--A list of IP SLAs operation ID numbers in the scheduled operation group.
- Schedule period--Amount of time for which the IP SLAs operation group is scheduled.
- Ageout--Amount of time to keep the operation in memory when it is not actively collecting information. By default, the operation remains in memory indefinitely.
- Frequency--Amount of time after which each IP SLAs operation is restarted. When the frequency option is specified, it overwrites the operation frequency of all operations belonging to the group. Note that when the frequency option is not specified, the frequency for each operation is set to the value of the schedule period.
- Life--Amount of time the operation actively collects information. The operation can be configured to run indefinitely. By default, the lifetime of an operation is one hour.
- Start time--Time when the operation starts collecting information. You can specify an operation to start immediately or at an absolute start time using hours, minutes, seconds, day, and month.

The IP SLAs multiple operations scheduling functionality schedules the maximum number of operations possible without aborting. However, this functionality skips those IP SLAs operations that are already running or those that are not configured and hence do not exist. The total number of operations will be calculated based on the number of operations specified in the command, irrespective of the number of operations that are missing or already running. The IP SLAs multiple operations scheduling functionality displays a message showing the number of active and missing operations. However, these messages are displayed only if you schedule operations that are not configured or are already running.

A main benefit for scheduling multiple IP SLAs operations is that the load on the network is reduced by distributing the operations equally over a scheduled period. This distribution helps you to achieve more consistent monitoring coverage. To illustrate this scenario, consider configuring 60 operations to start during the same 1-second interval over a 60-second schedule period. If a network failure occurs 30 seconds after all 60 operations have started and the network is restored before the operations are due to start again (in another 30 seconds), then this failure would never be detected by any of the 60 operations. However, if the 60 operations are distributed equally at 1-second intervals over a 60-second schedule period, then some of the operations would detect the network failure. Conversely, if a network failure occurs when all 60 operations are active, then all 60 operations would fail, indicating that the failure is possibly more severe than it really is.

Operations of the same type and same frequency should be used for IP SLAs multiple operations scheduling. If you do not specify a frequency, the default frequency will be the same as that of the schedule period. The schedule period is the period of time in which all the specified operations should run.

The following sections focus on the interaction of the schedule period and frequency values, additional values, such as start time and lifetime values, are not included in the illustrations.

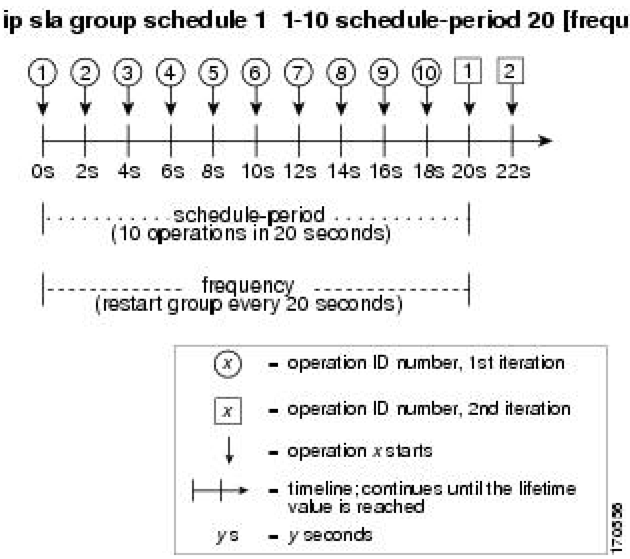
- Default Behavior of IP SLAs Multiple Operations Scheduling, page 201
- IP SLAs Multiple Operations Scheduling with Scheduling Period Less Than Frequency, page 202
- Multiple Operations Scheduling When the Number of IP SLAs Operations Are Greater Than the Schedule Period, page 203
- IP SLAs Multiple Operations Scheduling with Scheduling Period Greater Than Frequency, page 204

Default Behavior of IP SLAs Multiple Operations Scheduling

The IP SLAs Multiple Operations Scheduling feature allows you to schedule multiple IP SLAs operations as a group.

The figure below illustrates the scheduling of operation group 1 that includes operation 1 to operation 10. Operation group 1 has a schedule period of 20 seconds, which means that all operations in the group will be started at equal intervals within a 20-second period. By default, the frequency is set to the same value as the configured schedule period. As shown in the figure below, configuring the frequencyis optional because 20 is the default.

Figure 17: Schedule Period Equals Frequency--Default Behavior



```
ip sla group schedule 1  1-10 schedule-period 20 [frequency 20]
```

1
2
3
4
5
6
7
8
9
10
1
2
0s
2s
4s
6s
8s
10s
12s
14s
16s
18s
20s
22s
schedule-period
(10 operations in 20 seconds)
frequency
(restart group every 20 seconds)
x - operation ID number, 1st iteration
x - operation ID number, 2nd iteration
- operation x starts
- timeline; continues until the lifetime value is reached
ys - y seconds
170536

In this example, the first operation (operation 1) in operation group 1 will start at 0 seconds. All 10 operations in operation group 1 (operation 1 to operation 10) must be started in the schedule period of 20 seconds. The start time of each IP SLAs operation is evenly distributed over the schedule period by dividing the schedule period by the number of operations (20 seconds divided by 10 operations). Therefore, each operation will start 2 seconds after the previous operation.

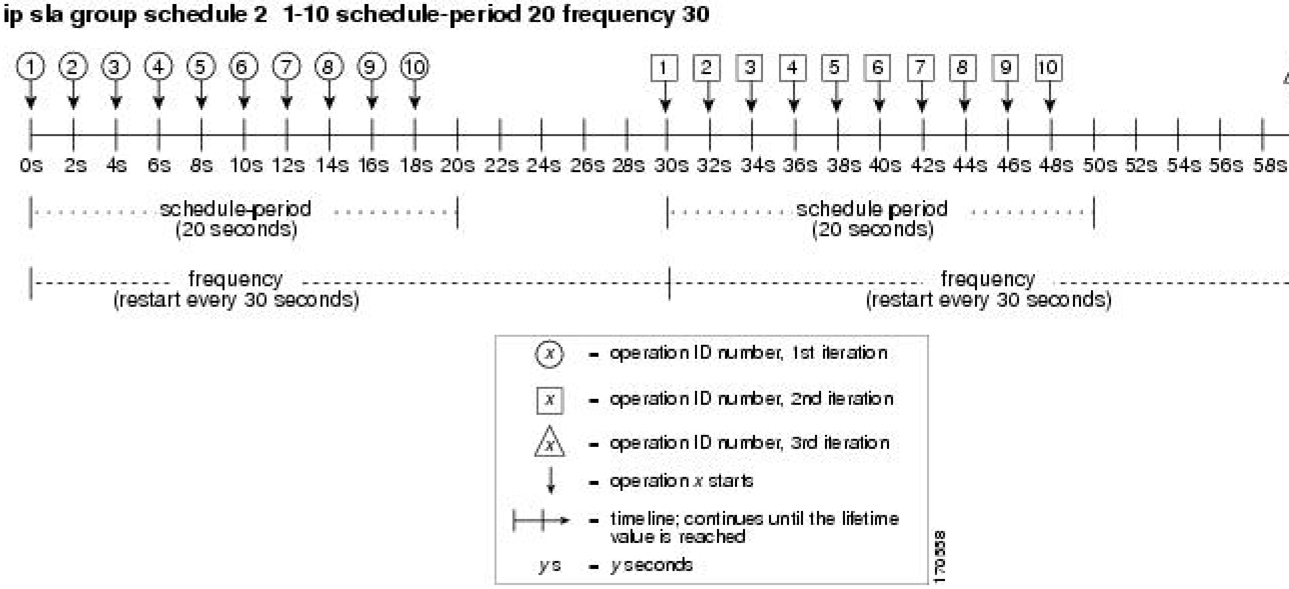
The frequency is the period of time that passes before the operation group is started again (repeated). If the frequency is not specified, the frequency is set to the value of the schedule period. In the example shown above, operation group 1 will start again every 20 seconds. This configuration provides optimal division (spacing) of operations over the specified schedule period.

IP SLAs Multiple Operations Scheduling with Scheduling Period Less Than Frequency

The frequency value is the amount of time that passes before the schedule group is restarted, if the schedule period is less than the frequency, there will be a period of time in which no operations are started.

The figure below illustrates the scheduling of operation 1 to operation 10 within operation group 2. Operation group 2 has a schedule period of 20 seconds and a frequency of 30 seconds.

Figure 18: Schedule Period Is Less Than Frequency


ip sla group schedule 2 1-10 schedule-period 20 frequency 30
1 2 3 4 5 6 7 8 9 10
1 2 3 4 5 6 7 8 9 10
0s 2s 4s 6s 8s 10s 12s 14s 16s 18s 20s 22s 24s 26s 28s 30s 32s 34s 36s 38s 40s 42s 44s 46s 48s 50s 52s 54s 56s 58s
schedule-period (20 seconds)
schedule period (20 seconds)
frequency (restart every 30 seconds)
frequency (restart every 30 seconds)
x - operation ID number, 1st iteration
x - operation ID number, 2nd iteration
x - operation ID number, 3rd iteration
- operation x starts
- time line; continues until the lifetime value is reached
ys - y seconds
170558

In this example, the first operation (operation 1) in operation group 2 will start at 0 seconds. All 10 operations in operation group 2 (operation 1 to operation 10) must be started in the schedule period of 20 seconds. The start time of each IP SLAs operation is evenly distributed over the schedule period by dividing the schedule period by the number of operations (20 seconds divided by 10 operations). Therefore, each operation will start 2 seconds after the previous operation.

In the first iteration of operation group 2, operation 1 starts at 0 seconds, and the last operation (operation 10) starts at 18 seconds. However, because the group frequency has been configured to 30 seconds each operation in the operation group is restarted every 30 seconds. So, after 18 seconds, there is a gap of 10 seconds as no operations are started in the time from 19 seconds to 29 seconds. Hence, at 30 seconds, the second iteration of operation group 2 starts. As all ten operations in the operation group 2 must start at an evenly distributed interval in the configured schedule period of 20 seconds, the last operation (operation 10) in the operation group 2 will always start 18 seconds after the first operation (operation 1).

As illustrated in the figure above, the following events occur:

- At 0 seconds, the first operation (operation 1) in operation group 2 is started.

- At 18 seconds, the last operation (operation 10) in operation group 2 is started. This means that the first iteration (schedule period) of operation group 1 ends here.
- From 19 to 29 seconds, no operations are started.
- At 30 seconds, the first operation (operation 1) in operation group 2 is started again. The second iteration of operation group 2 starts here.
- At 48 seconds (18 seconds after the second iteration started) the last operation (operation 10) in operation group 2 is started, and the second iteration of operation group 2 ends.
- At 60 seconds, the third iteration of operation group 2 starts.

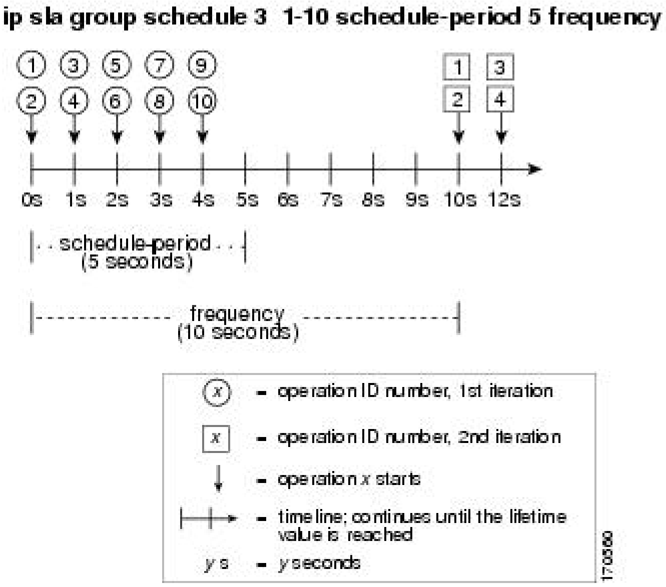
This process continues until the lifetime of operation group 2 ends. The lifetime value is configurable. The default lifetime for an operation group is forever.

Multiple Operations Scheduling When the Number of IP SLAs Operations Are Greater Than the Schedule Period

The minimum time interval between the start of IP SLAs operations in a group operation is 1 second. Therefore, if the number of operations to be multiple scheduled is greater than the schedule period, the IP SLAs multiple operations scheduling functionality will schedule more than one operation to start within the same 1-second interval. If the number of operations getting scheduled does not equally divide into 1-second intervals, then the operations are equally divided at the start of the schedule period with the remaining operations to start at the last 1-second interval.

The figure below illustrates the scheduling of operation 1 to operation 10 within operation group 3. Operation group 3 has a schedule period of 5 seconds and a frequency of 10 seconds.

Figure 19: Number of IP SLAs Operations Is Greater Than the Schedule Period--Even Distribution


ip sla group schedule 3 1-10 schedule-period 5 frequency 10
1
2
3
4
5
6
7
8
9
10
1
2
3
4
0s
1s
2s
3s
4s
5s
6s
7s
8s
9s
10s
12s
schedule-period
(5 seconds)
frequency
(10 seconds)
x - operation ID number, 1st iteration
x - operation ID number, 2nd iteration
- operation x starts
- time line; continues until the lifetime value is reached
y s - y seconds
170560

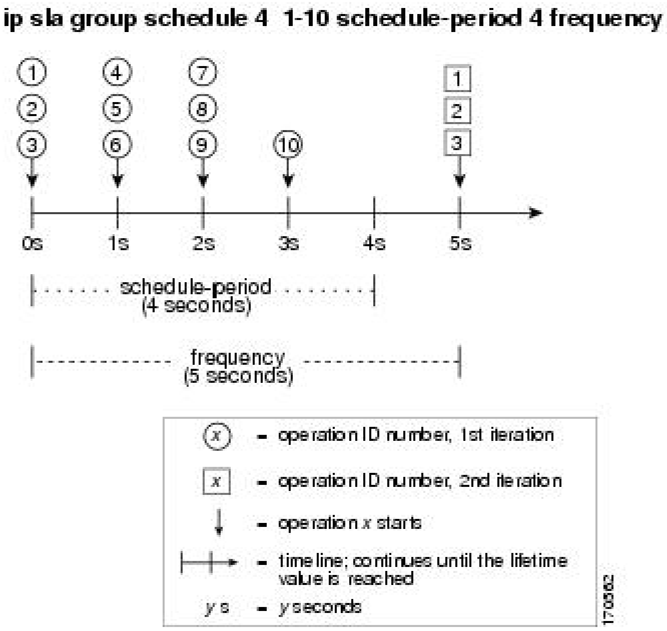
In this example, when dividing the schedule period by the number of operations (5 seconds divided by 10 operations, which equals one operation every 0.5 seconds) the start time of each IP SLAs operation is less than 1 second. Since the minimum time interval between the start of IP SLAs operations in a group operation is 1 second, the IP SLAs multiple operations scheduling functionality instead calculates how many operations it should start in each 1-second interval by dividing the number of operations by the schedule period (10 operations divided by 5 seconds). Therefore, as shown in the figure above, two operations will be started every 1 second.

As the frequency is set to 10 in this example, each iteration of operation group 3 will start 10 seconds after the start of the previous iteration. However, this distribution is not optimal as there is a gap of 5 seconds (frequency minus schedule period) between the cycles.

If the number of operations getting scheduled does not equally divide into 1-second intervals, then the operations are equally divided at the start of the schedule period with the remaining operations to start at the last 1-second interval.

The figure below illustrates the scheduling of operation 1 to operation 10 within operation group 4. Operation group 4 has a schedule period of 4 seconds and a frequency of 5 seconds.

Figure 20: Number of IP SLAs Operations Is Greater Than the Schedule Period--Uneven Distribution



```
ip sla group schedule 4  1-10 schedule-period 4 frequency 5
```

1
2
3
4
5
6
7
8
9
10
1
2
3
0s
1s
2s
3s
4s
5s
schedule-period
(4 seconds)
frequency
(5 seconds)
x - operation ID number, 1st iteration
x - operation ID number, 2nd iteration
- operation x starts
- time line; continues until the lifetime value is reached
y s - y seconds
170562

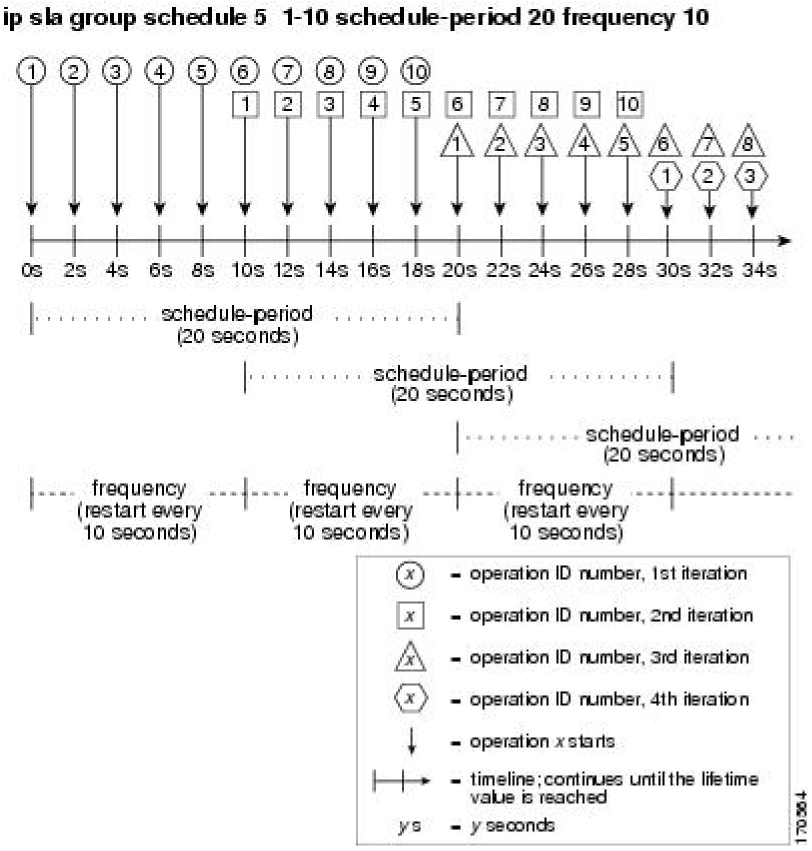
In this example, the IP SLAs multiple operations scheduling functionality calculates how many operations it should start in each 1-second interval by dividing the number of operations by the schedule period (10 operations divided by 4 seconds, which equals 2.5 operations every 1 second). Since the number of operations does not equally divide into 1-second intervals, this number will be rounded off to the next whole number (see the figure above) with the remaining operations to start at the last 1-second interval.

IP SLAs Multiple Operations Scheduling with Scheduling Period Greater Than Frequency

The value of frequency is the amount of time that passes before the schedule group is restarted. If the schedule period is greater than the frequency, there will be a period of time in which the operations in one iteration of an operation group overlap with the operations of the following iteration.

The figure below illustrates the scheduling of operation 1 to operation 10 within operation group 5. Operation group 5 has a schedule period of 20 seconds and a frequency of 10 seconds.

Figure 21: IP SLAs Group Scheduling with Schedule Period Greater Than Frequency


ip sla group schedule 5 1-10 schedule-period 20 frequency 10
1 2 3 4 5 6 7 8 9 10
1 2 3 4 5 6 7 8 9 10
1 2 3 4 5 6 7 8
1 2 3
0s 2s 4s 6s 8s 10s 12s 14s 16s 18s 20s 22s 24s 26s 28s 30s 32s 34s
schedule-period (20 seconds)
schedule-period (20 seconds)
schedule-period (20 seconds)
frequency (restart every 10 seconds)
frequency (restart every 10 seconds)
frequency (restart every 10 seconds)
x - operation ID number, 1st iteration
x - operation ID number, 2nd iteration
x - operation ID number, 3rd iteration
x - operation ID number, 4th iteration
- operation x starts
- timeline; continues until the lifetime value is reached
ys - y seconds
170384

In this example, the first operation (operation 1) in operation group 5 will start at 0 seconds. All 10 operations in operation group 5 (operation 1 to operation 10) must be started in the schedule period of 20 seconds. The start time of each IP SLAs operation is evenly distributed over the schedule period by dividing the schedule period by the number of operations (20 seconds divided by 10 operations). Therefore, each operation will start 2 seconds after the previous operation.

In the first iteration of operation group 5, operation 1 starts at 0 seconds, and operation 10, the last operation in the operation group, starts at 18 seconds. Because the operation group is configured to restart every 10 seconds (**frequency 10**), the second iteration of operation group 5 starts again at 10 seconds, before the first iteration is completed. Therefore, an overlap of operations 6 to 10 of the first iteration occurs with operations 1 to 5 of the second iteration during the time period of 10 to 18 seconds (see the figure above). Similarly, there is an overlap of operations 6 to 10 of the second iteration with operations 1 to 5 of the third iteration during the time period of 20 to 28 seconds.

In this example, the start time of operation 1 and operation 6 need not be at exactly the same time, but will be within the same 2-second interval.

The configuration described in this section is not recommended as you can configure multiple operations to start within the same 1-second interval by configuring the number of operations greater than the schedule period. For information, see the "Multiple Operations Scheduling When the Number of IP SLAs Operations Are Greater Than the Schedule Period" section.

IP SLAs Random Scheduler

The IP SLAs Random Scheduler feature is an enhancement to the existing IP SLAs Multioperation Scheduling feature. The IP SLAs Multioperation Scheduling feature provides the capability to easily schedule multiple IP SLAs operations to begin at intervals equally distributed over a specified duration of time and to restart at a specified frequency. With the IP SLAs Random Scheduler feature, you can now schedule multiple IP SLAs operations to begin at random intervals uniformly distributed over a specified duration of time and to restart at uniformly distributed random frequencies within a specified frequency range. Random scheduling improves the statistical metrics for assessing network performance.

Note The IP SLAs Random Scheduler feature is not in compliance with RFC2330 because it does not account for inter-packet randomness.

The IP SLAs random scheduler option is disabled by default. To enable the random scheduler option, you must set a frequency range when configuring a group schedule in global configuration mode. The group of operations restarts at uniformly distributed random frequencies within the specified frequency range. The following guidelines apply for setting the frequency range:

- The starting value of the frequency range should be greater than the timeout values of all the operations in the group operation.
- The starting value of the frequency range should be greater than the schedule period (amount of time for which the group operation is scheduled). This guideline ensures that the same operation does not get scheduled more than once within the schedule period.

The following guidelines apply if the random scheduler option is enabled:

- The individual operations in a group operation will be uniformly distributed to begin at random intervals over the schedule period.
- The group of operations restarts at uniformly distributed random frequencies within the specified frequency range.
- The minimum time interval between the start of each operation in a group operation is 100 milliseconds (0.1 seconds). If the random scheduler option is disabled, the minimum time interval is 1 second.
- Only one operation can be scheduled to begin at any given time. If the random scheduler option is disabled, multiple operations can begin at the same time.
- The first operation will always begin at 0 milliseconds of the schedule period.
- The order in which each operation in a group operation begins is random.

How to Configure an IP SLAs Multioperation Scheduler

Scheduling Multiple IP SLAs Operations

Note

- All IP SLAs operations to be scheduled must be already configured.
- The frequency of all operations scheduled in a multioperation group should be the same.
- List of one or more operation ID numbers to be added to a multioperation group is limited to a maximum of 125 characters, including commas (,).

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip sla group schedule** *group-operation-number operation-id-numbers* **schedule-period** *schedule-period-range* [**ageout** *seconds*] [**frequency** *group-operation-frequency*] [**life**{**forever** | *seconds*}] [**start-time**{*hh:mm*[*:ss*] [*month day* | *day month*] | **pending** | **now** | **after** *hh:mm:ss*}]
4. **exit**
5. **show ip sla group schedule**
6. **show ip sla configuration**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**ip sla group schedule** *group-operation-number operation-id-numbers* **schedule-period** *schedule-period-range* [**ageout** *seconds*] [**frequency** *group-operation-frequency*] [**life**{**forever** | *seconds*}] [**start-time**{*hh:mm*[*:ss*] [*month day* | *day month*] | **pending** | **now** | **after** *hh:mm:ss*}] **Example:** `Router(config)# ip sla group schedule 1 3,4,6-9`	Specifies an IP SLAs operation group number and the range of operation numbers to be scheduled in global configuration mode.
Step 4	**exit** **Example:** `Router(config)# exit`	Returns to the privileged EXEC mode.
Step 5	**show ip sla group schedule**	(Optional) Displays the IP SLAs group schedule details.

	Command or Action	Purpose
	Example: `Router# show ip sla group schedule`	
Step 6	**show ip sla configuration** **Example:** `Router# show ip sla configuration`	(Optional) Displays the IP SLAs configuration details.

Enabling the IP SLAs Random Scheduler

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip sla group schedule** *group-operation-number operation-id-numbers* **schedule-period** *seconds* [**ageout** *seconds*] [**frequency** [*seconds*| **range** *random-frequency-range*]] [**life**{**forever** | *seconds*}] [**start-time**{*hh:mm*[*:ss*] [*month day* | *day month*] | **pending** | **now** | **after** *hh:mm:ss*}]
4. **exit**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**ip sla group schedule** *group-operation-number operation-id-numbers* **schedule-period** *seconds* [**ageout** *seconds*] [**frequency** [*seconds*| **range** *random-frequency-range*]] [**life**{**forever**	*seconds*}] [**start-time**{*hh:mm*[*:ss*] [*month day*	*day month*]	**pending**	**now**	**after** *hh:mm:ss*}] **Example:** `Router(config)# ip sla group schedule 2 1-3 schedule-period 50 frequency range 80-100`	Specifies the scheduling parameters of a group of IP SLAs operations. • To enable the IP SLAs random scheduler option, you must configure the **frequency range** *random-frequency-range* keywords and argument.

	Command or Action	Purpose
Step 4	**exit** **Example:** `Router(config)# exit`	Exits global configuration mode and returns to privileged EXEC mode.

Verifying IP SLAs Multiple Operations Scheduling

SUMMARY STEPS

1. **show ip sla statistics**
2. **show ip sla group schedule**
3. **show ip sla configuration**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**show ip sla statistics** **Example:** `Router# show ip sla statistics`	(Optional) Displays the IP SLAs operation details.
Step 2	**show ip sla group schedule** **Example:** `Router# show ip sla group schedule`	(Optional) Displays the IP SLAs group schedule details.
Step 3	**show ip sla configuration** **Example:** `Router# show ip sla configuration`	(Optional) Displays the IP SLAs configuration details.

Examples

After you have scheduled the multiple IP SLAs operations, you can verify the latest operation details using the appropriate **show** commands.

The following example schedules IP SLAs operations 1 through 20 in the operation group 1 with a schedule period of 60 seconds and a life value of 1200 seconds. By default, the frequency is equivalent to the schedule period. In this example, the start interval is 3 seconds (schedule period divided by number of operations).

```
Router# ip sla group schedule 1 1-20 schedule-period 60 life 1200
```

The following example shows the details of the scheduled multiple IP SLAs operation using the **show ip sla group schedule** command.

```
Router# show ip sla group schedule
```

```
Group Entry Number: 1
Probes to be scheduled: 1-20
Total number of probes: 20
Schedule period: 60
Group operation frequency: Equals schedule period
Status of entry (SNMP RowStatus): Active
Next Scheduled Start Time: Start Time already passed
Life (seconds): 1200
Entry Ageout (seconds): never
```

The following example shows the details of the scheduled multiple IP SLAs operation using the **show ip sla configuration** command. The last line in the example indicates that the IP SLAs operations are multiple scheduled (TRUE).

```
Router# show ip sla configuration 1
Entry number: 1
Owner:
Tag:
Type of operation to perform: udpEcho
Target address: 10.2.31.121
Source address: 0.0.0.0
Target port: 9001
Source port: 0
Request size (ARR data portion): 16
Operation timeout (milliseconds): 5000
Type Of Service parameters: 0x0
Verify data: No
Data pattern:
Vrf Name:
Control Packets: enabled
Operation frequency (seconds): 60
Next Scheduled Start Time: Start Time already passed
Life (seconds): 1200
Entry Ageout (seconds): never
Recurring (Starting Everyday): FALSE
Status of entry (SNMP RowStatus): Active
Threshold (milliseconds): 5000
Number of statistic hours kept: 2
Number of statistic distribution buckets kept: 1
Statistic distribution interval (milliseconds): 20
Enhanced History:
Number of history Lives kept: 0
Number of history Buckets kept: 15
History Filter Type: None
Group Scheduled : TRUE
```

The following example shows the latest operation start time of the scheduled multiple IP SLAs operation, when the operations are scheduled at equal intervals, using the **show ip sla statistics** command:

```
Router# show ip sla statistics | include Latest operation start time
Latest operation start time: *03:06:21.760 UTC Tue Oct 21 2003
Latest operation start time: *03:06:24.754 UTC Tue Oct 21 2003
Latest operation start time: *03:06:27.751 UTC Tue Oct 21 2003
Latest operation start time: *03:06:30.752 UTC Tue Oct 21 2003
Latest operation start time: *03:06:33.754 UTC Tue Oct 21 2003
Latest operation start time: *03:06:36.755 UTC Tue Oct 21 2003
Latest operation start time: *03:06:39.752 UTC Tue Oct 21 2003
Latest operation start time: *03:06:42.753 UTC Tue Oct 21 2003
Latest operation start time: *03:06:45.755 UTC Tue Oct 21 2003
Latest operation start time: *03:06:48.752 UTC Tue Oct 21 2003
Latest operation start time: *03:06:51.753 UTC Tue Oct 21 2003
Latest operation start time: *03:06:54.755 UTC Tue Oct 21 2003
Latest operation start time: *03:06:57.752 UTC Tue Oct 21 2003
Latest operation start time: *03:07:00.753 UTC Tue Oct 21 2003
Latest operation start time: *03:07:03.754 UTC Tue Oct 21 2003
Latest operation start time: *03:07:06.752 UTC Tue Oct 21 2003
Latest operation start time: *03:07:09.752 UTC Tue Oct 21 2003
Latest operation start time: *03:07:12.753 UTC Tue Oct 21 2003
Latest operation start time: *03:07:15.755 UTC Tue Oct 21 2003
Latest operation start time: *03:07:18.752 UTC Tue Oct 21 2003
```

Configuration Examples for an IP SLAs Multioperation Scheduler

Example Scheduling Multiple IP SLAs Operations

The following example schedules IP SLAs operations 1 to 10 in the operation group 1 with a schedule period of 20 seconds. By default, the frequency is equivalent to the schedule period.

```
Router# ip sla group schedule 1 1-10 schedule-period 20
```

The following example shows the details of the scheduled multiple IP SLAs operation using the **show ip sla group schedule** command. The last line in the example indicates that the IP SLAs operations are multiple scheduled (TRUE).

```
Router# show ip sla group schedule
Multi-Scheduling Configuration:
Group Entry Number: 1
Probes to be scheduled: 1-10
Schedule period :20
Group operation frequency: 20
Multi-scheduled: TRUE
```

Example Enabling the IP SLAs Random Scheduler

The following example shows how to schedule IP SLAs operations 1 to 3 as a group (identified as group 2). In this example, the operations are scheduled to begin at uniformly distributed random intervals over a schedule period of 50 seconds. The first operation is scheduled to start immediately. The interval is chosen from the specified range upon every invocation of the probe. The random scheduler option is enabled and the uniformly distributed random frequencies at which the group of operations will restart is chosen within the range of 80-100 seconds.

```
ip sla group schedule 2 1-3 schedule-period 50 frequency range 80-100 start-time now
```

Additional References

Related Documents

Related Topic	Document Title
Cisco IOS commands	Cisco IOS Master Commands List, All Releases
Cisco IOS IP SLAs commands	*Cisco IOS IP SLAs Command Reference*

Standards

Standards	Title
No new or modified standards are supported by this feature.	--

MIBs

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

RFCs

RFCs	Title
No new or modified RFCs are supported by this feature.	--

Technical Assistance

Description	Link
The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.	http://www.cisco.com/cisco/web/support/index.html

Feature Information for a IP SLAs Multioperation Scheduler

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 http://www.cisco.com/go/cfn. An account on Cisco.com is not required.

Table 23: Feature Information for IP SLAs Multiple Operation Scheduling

Feature Name	Releases	Feature Information
IP SLAs Multioperation Scheduler	Cisco IOS XE Release 2.1	The IP SLAs Multioperation Scheduler feature provides a highly scalable infrastructure for IP SLAs by allowing you to schedule multiple IP SLAs operations using a single command.
IP SLAs Random Scheduler	Cisco IOS XE Release 2.1	The IP SLAs Random Scheduler feature provides the capability to schedule multiple IP SLAs operations to begin at random intervals uniformly distributed over a specified duration of time and to restart at uniformly distributed random frequencies within a specified frequency range.

Any Internet Protocol (IP) addresses and phone numbers used in this document are not intended to be actual addresses and phone numbers. Any examples, command display output, network topology diagrams, and other figures included in the document are shown for illustrative purposes only. Any use of actual IP addresses or phone numbers in illustrative content is unintentional and coincidental.

Configuring Proactive Threshold Monitoring for IP SLAs Operations

This document describes the proactive monitoring capabilities of IP Service Level Agreements (SLAs) using thresholds and reaction triggering.

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest feature information and caveats, see the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the Feature Information Table at the end of this document.

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

Information About Proactive Threshold Monitoring

IP SLAs Reaction Configuration

IP SLAs reactions are configured to trigger when a monitored value exceeds or falls below a specified level or when a monitored event, such as a timeout or connection loss, occurs. If IP SLAs measures too high or too low of any configured reaction, IP SLAs can generate a notification to a network management application or trigger another IP SLA operation to gather more data.

Supported Reactions by IP SLAs Operation

The tables below list which reactions are supported for each IP SLA operation.

Table 24: Supported Reaction Configuration, by IP SLA Operation

Reaction	ICMP Echo	Path Echo	UDP Jitter	UDP Echo	TCP Connect	DHCP	DLSW	ICMP Jitter	DNS	Frame Relay
Failure	Y	--	Y	Y	Y	Y	--	Y	Y	--
RTT	Y	Y	--	Y	Y	Y	Y	--	Y	Y
RTTAvg	--	--	Y	--	--	--	--	Y	--	--
timeout	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
connectionLoss	--	--	Y	Y	Y	--	--	--	--	
verifyError	--	--	Y	Y	--	--	--	Y	--	Y
jitterSDAvg	--	--	Y	--	--	--		Y	--	--
jitterAvg	--	--	Y	--	--	--	--	Y	--	--
packetLateArrival	--	--	Y	--	--	--	--	Y	--	--
packetOutOfSequence	--	--	Y	--	--	--	--	Y	--	--
MaxOfPostiveSD	--	--	Y	--	--	--		Y	--	--
MaxOfNegativeSD	--	--	Y	--	--	--	--	Y	--	--
MaxOfPostiveDS	--	--	Y	--	--	--	--	Y	--	--
MaxOfNegativeDS	--	--	Y	--	--	--	--	Y	--	--
MOS	--	--	Y	--	--	--		--	--	--
ICPIF	--	--	Y	--	--	--	--	--	--	--
PacketLossDS	--	--	Y	--	--	--	--	--	--	--

Reaction	ICMP Echo	Path Echo	UDP Jitter	UDP Echo	TCP Connect	DHCP	DLSW	ICMP Jitter	DNS	Frame Relay
PacketLossSD	--	--	Y	--	--	--	--	--	--	--
PacketMIA	--	--	Y	--	--	--		--	--	--
iaJitterDS	--	--	--	--	--	--	--	--	--	--
frameLossDS	--	--	--	--	--	--	--	--	--	--
mosLQDSS	--	--	--	--	--	--	--	--	--	--
mosCQDS	--	--	--	--	--	--	--	--	--	--
rfactorDS	--	--	--	--	--	--	--	--	--	--
iaJitterSD	--	--	--	--	--	--	--	--	--	--
successivePacketLoss	--	--	--	--	--	--	--	Y	--	--
MaxOfLatencyDS	--	--	--	--	--	--	--	Y	--	--
MaxOfLatencySD	--	--	--	--	--	--	--	Y	--	--
LatencyDS	--	--	--	--	--	--	--	Y	--	--
LatencySD	--	--	--	--	--	--	--	Y	--	--
packetLoss	--	--	--	--	--	--	--	Y	--	--

Table 25: Supported Reaction Configuration, by IP SLA Operation

Reaction	HTTP	SLM	RTP	FTP	Lsp Trace	Post delay	Path Jitter	LSP Ping	Gatekeeper Registration
Failure	--	--	--	--	--	--	--	--	--
RTT	Y	Y	Y	Y	Y	Y	Y	Y	Y

Reaction	HTTP	SLM	RTP	FTP	Lsp Trace	Post delay	Path Jitter	LSP Ping	Gatekeeper Registration
RTTAvg	--	--	--	--	--	--	--	--	--
timeout	Y	Y	Y	Y	--	Y	Y	Y	Y
connectionLoss	Y		Y	Y	Y	--	--	Y	--
verifyError	--	--	--	--	--	--	--	--	--
jitterSDAvg	--	--	--	--	--	--	Y	--	--
jitterAvg	--	--	--	--	--	--	Y	--	--
packetLateArrival	--	--	--	--	--	--	Y	--	--
packetOutOfSequence	--	--	--	--	--	--	Y	--	--
MaxOfPostiveSD	--	--	--	--	--	--	Y	--	--
MaxOfNegativeSD	--	--	--	--	--	--	Y	--	--
MaxOfPostiveDS	--	--	--	--	--	--	Y	--	--
MaxOfNegativeDS	--	--	--	--	--	--	Y	--	--
MOS	--	--	--	--	--	--	--	--	--
ICPIF	--	--	--	--	--	--	--	--	--
PacketLossDS	--	--	Y	--	--	--	--	--	--
PacketLossSD	--	--	Y	--	--	--	--	--	--
PacketMIA	--	--	Y	--	--	--	--	--	--
iaJitterDS	--	--	Y	--	--	--	--	--	--
frameLossDS	--	--	Y	--	--	--	--	--	--

Reaction	HTTP	SLM	RTP	FTP	Lsp Trace	Post delay	Path Jitter	LSP Ping	Gatekeeper Registration
mosLQDSS	--	--	Y	--	--	--	--	--	--
mosCQDS	--	--	Y	--	--	--	--	--	--
rfactorDS	--	--	Y						
iaJitterSD	--	--	Y	--	--	--	--	--	--
successivePacketLoss	--	--	--	--	--	--	--	--	--
MaxOfLatencyDS	--	--	--	--	--	--	--	--	--
MaxOfLatencySD	--	--	--	--	--	--	--	--	--
LatencyDS	--	--	--	--	--	--	--	--	--
LatencySD	--	--	--	--	--	--	--	--	--
packetLoss	--	--	--	--	--	--	--	--	--

IP SLAs Threshold Monitoring and Notifications

IP SLAs supports proactive threshold monitoring and notifications for performance parameters such as average jitter, unidirectional latency, bidirectional round-trip time (RTT), and connectivity for most IP SLAs operations. The proactive monitoring capability also provides options for configuring reaction thresholds for important VoIP related parameters including unidirectional jitter, unidirectional packet loss, and unidirectional VoIP voice quality scoring.

Notifications for IP SLAs are configured as a triggered reaction. Packet loss, jitter, and Mean Operation Score (MOS) statistics are specific to IP SLAs jitter operations. Notifications can be generated for violations in either direction (source-to-destination and destination-to-source) or for out-of-range RTT values for packet loss and jitter. Events, such as traps, are triggered when the RTT value rises above or falls below a specified threshold.

IP SLAs can generate system logging (syslog) messages when a reaction condition occurs. System logging messages can be sent as Simple Network Management Protocol (SNMP) traps (notifications) using the CISCO-RTTMON-MIB. SNMP traps for IP SLAs are supported by the CISCO-RTTMON-MIB and CISCO-SYSLOG-MIB.

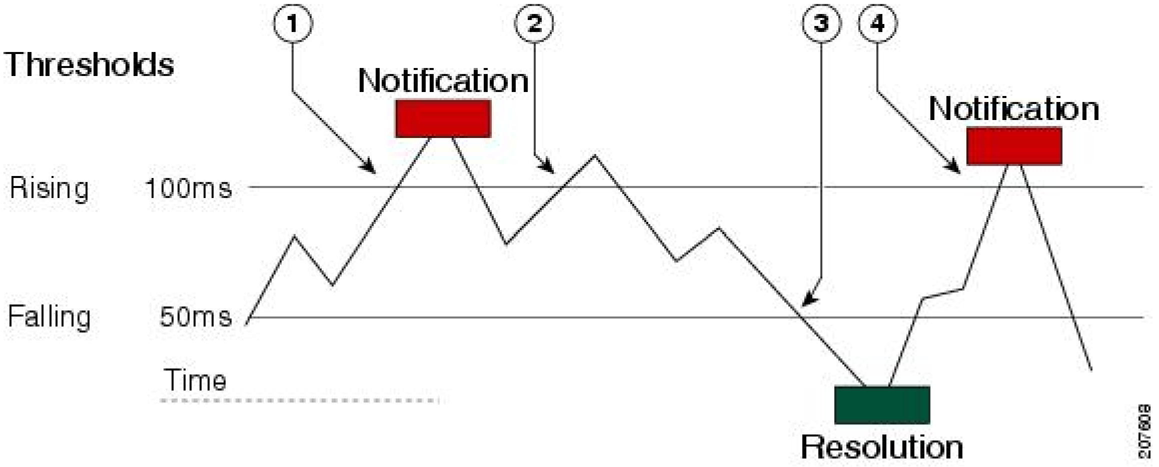
Severity levels in the CISCO-SYSLOG-MIB are defined as follows: SyslogSeverity INTEGER {emergency(1), alert(2), critical(3), error(4), warning(5), notice(6), info(7), debug(8)}

The values for severity levels are defined differently for the system logging process in software. Severity levels for the system logging process in Cisco software are defined as follows: {emergency (0), alert (1), critical (2), error (3), warning (4), notice (5), informational (6), debugging (7)}.

IP SLAs Threshold violations are logged as level 6 (informational) within the Cisco system logging process but are sent as level 7 (info) traps from the CISCO-SYSLOG-MIB.

Notifications are not issued for every occurrence of a threshold violation. The figure below illustrates the sequence for a triggered reaction that occurs when the monitored element exceeds the upper threshold. An event is sent and a notification is issued when the rising threshold is exceeded for the first time. Subsequent threshold-exceeded notifications are issued only after the monitored value falls below the falling threshold before exceeding the rising threshold ag ain .

Figure 22: IP SLAs Triggered Reaction Condition and Notifications for Threshold Exceeded



1	An event is sent and a threshold-exceeded notification is issued when the rising threshold is exceeded for the first time.
2	Consecutive over-rising threshold violations occur without issuing additional notifications.
3	The monitored value goes below the falling threshold.
4	Another threshold-exceeded notification is issued when the rising threshold is exceeded only after the monitored value first fell below the falling threshold.

Note A lower-threshold notification is also issued the first time that the monitored element falls below the falling threshold (3). As described, subsequent notifications for lower-threshold violations will be issued only after the rising threshold is exceeded before the monitored value falls below the falling threshold again.

- RTT Reactions for Jitter Operations, page 220

RTT Reactions for Jitter Operations

RTT reactions for jitter operations are triggered only at the end of the operation and use the latest value for the return-trip time (LatestRTT), which matches the value of the average return-trip time (RTTAvg).

SNMP traps for RTT for jitter operations are based on the value of the average return-trip time (RTTAvg) for the whole operation and do not include RTT values for each individual packet sent during the operation. For example, if the average is below the threshold, up to half of the packets can actually be above threshold but this detail is not included in the notification because the value is for the whole operation only.

Only syslog messages are supported for RTTAvg threshold violations. Syslog nmessages are sent from the CISCO-RTTMON-MIB.

How to Configure Proactive Threshold Monitoring

Configuring Proactive Threshold Monitoring

Perform this task to configure thresholds and reactive triggering for generating traps or starting another operation.

- IP SLAs operations to be started when violation conditions are met must be configured.

Note

- RTT reactions for jitter operations are triggered only at the end of the operation and use the latest value for the return-trip time (LatestRTT).
- SNMP traps for RTT for jitter operations are based on the average value for the return-trip time (RTTAvg) for the whole operation only and do not include return-trip time values for individual packets sent during the operation. Only syslog messages are supported for RTTAvg threshold violations.
- Only syslog messages are supported for RTT violations during Jitter operations.
- Only SNMP traps are supported for RTT violations during non-Jitter operations.
- Only syslog messages are supported for non-RTT violations other than timeout, connectionLoss, or verifyError.
- Both SNMP traps and syslog messages are supported for timeout, connectionLoss, or verifyError violations only.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip sla reaction-configuration** *operation-number* **react** *monitored-element* [**action-type** *option*] [**threshold-type** {**average** [*number-of-measurements*] | **consecutive** [*occurrences*] | **immediate** | **never** | **xofy** [*x-value y-value*]}] [**threshold-value** *upper-threshold lower-threshold*]
4. **ip sla reaction-trigger** *operation-number target-operation*
5. **ip sla logging traps**
6. Do one of the following:
   - **snmp-server enable traps rtr**
   - **snmp-server enable traps syslog**
7. **snmp-server host** {*hostname* | *ip-address*} [**vrf** *vrf-name*] [**traps** | **informs**] [**version** {**1** | **2c** | **3** [**auth** | **noauth** | **priv**]}] *community-string* [**udp-port** *port*] [*notification-type*]
8. **exit**
9. **show ip sla reaction configuration** [*operation-number*]
10. **show ip sla reaction trigger** [*operation-number*]

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**ip sla reaction-configuration** *operation-number* **react** *monitored-element* [**action-type** *option*] [**threshold-type** {**average** [*number-of-measurements*] | **consecutive** [*occurrences*] | **immediate** | **never** | **xofy** [*x-value y-value*]}] [**threshold-value** *upper-threshold lower-threshold*] **Example:** `Router(config)# ip sla reaction-configuration 10 react jitterAvg threshold-type immediate threshold-value 5000 3000 action-type trapAndTrigger`	Configures the action (SNMP trap or IP SLAs trigger) that is to occur based on violations of specified thresholds.
Step 4	**ip sla reaction-trigger** *operation-number target-operation* **Example:** `Router(config)# ip sla reaction-trigger 10 2`	(Optional) Starts another IP SLAs operation when the violation conditions are met.

	Command or Action	Purpose
		• Required only if the **ip sla reaction-configuration** command is configured with either the **trapAndTrigger**or **triggerOnly**keyword.
Step 5	**ip sla logging traps** **Example:** `Router(config)# ip sla logging traps`	(Optional) Enables IP SLAs syslog messages from CISCO-RTTMON-MIB.

Step 6	Do one of the following:
	• **snmp-server enable traps rtr**
	• **snmp-server enable traps syslog**
	Example:
	`Router(config)# snmp-server enable traps rtr`
	Example:
	`Router(config)# snmp-server enable traps syslog`
		(Optional) Enables system to generate CISCO-RTTMON-MIB traps.
		or
		Enables system to generate CISCO-SYSLOG-MIB traps.

Step 7	**snmp-server host** {*hostname* | *ip-address*} [**vrf** *vrf-name*] [**traps** | **informs**] [**version** {**1** | **2c** | **3** [**auth** | **noauth** | **priv**]}] *community-string* [**udp-port** *port*] [*notification-type*] **Example:** `Router(config)# snmp-server host 10.1.1.1 public syslog`	(Optional) Sends traps to a remote host. • Required if the **snmp-server enable traps** command is configured.
Step 8	**exit** **Example:** `Router(config)# exit`	Exits global configuration mode and returns to privileged EXEC mode.
Step 9	**show ip sla reaction configuration** [*operation-number*] **Example:** `Router# show ip sla reaction configuration 10`	(Optional) Displays the configuration of proactive threshold monitoring.
Step 10	**show ip sla reaction trigger** [*operation-number*] **Example:** `Router# show ip sla reaction trigger 2`	(Optional) Displays the configuration status and operational state of target operations to be triggered.

Configuration Examples for Proactive Threshold Monitoring

- Example Configuring an IP SLAs Reaction Configuration, page 224
- Example Verifying an IP SLAs Reaction Configuration, page 224
- Example Triggering SNMP Notifications, page 225

Example Configuring an IP SLAs Reaction Configuration

In the following example, IP SLAs operation 10 is configured to send an SNMP logging trap when the MOS value either exceeds 4.9 (best quality) or falls below 2.5 (poor quality):

```
Router(config)# ip sla reaction-configuration 10 react mos threshold-type immediate
threshold-value 490 250 action-type trapOnly
```

The following example shows the default configuration for the **ip sla reaction-configuration** command:

```
Router# show ip sla reaction-configuration 1
Entry number: 1
Reaction Configuation not configured
Router# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)# ip sla reaction-configuration 1
Router(config)# do show ip sla reaction-configuration 1
Entry number: 1
Reaction: rtt
Threshold Type: Never
Rising (milliseconds): 5000
Falling (milliseconds): 3000
Threshold Count: 5
Threshold Count2: 5
Action Type: None
```

Example Verifying an IP SLAs Reaction Configuration

The following example shows that multiple monitored elements are configured for the IP SLAs operation (1), as indicated by the values of Reaction: in the output:

```
Router# show ip sla reaction-configuration

Entry Number: 1
Reaction: RTT
Threshold type: Never
Rising (milliseconds): 5000
Falling (milliseconds): 3000
Threshold Count: 5
Threshold Count2: 5
Action Type: None
Reaction: jitterDSAvg
Threshold type: average
Rising (milliseconds): 5
Falling (milliseconds): 3
Threshold Count: 5
Threshold Count2: 5
Action Type: triggerOnly
Reaction: jitterDSAvg
Threshold type:  immediate
Rising (milliseconds): 5
Falling (milliseconds): 3
Threshold Count: 5
Threshold Count2: 5
Action Type: trapOnly
Reaction: PacketLossSD
Threshold type:  immediate
Rising (milliseconds): 5
Threshold Falling (milliseconds): 3
Threshold Count: 5
Threshold Count2: 5
```

```
Action Type: trapOnly
```

Example Triggering SNMP Notifications

The following example shows how to configure proactive threshold monitoring so that CISCO-SYSLOG-MIB traps are sent to the remote host at 10.1.1.1 if the threshold values for RTT or VoIP MOS are violated:

```
! Configure the operation on source.
Router(config)# ip sla 1

Router(config-ip-sla)# udp-jitter 10.1.1.1 3000 codec g711alaw
Router(config-ip-sla-jitter)# exit

Router(config)# ip sla schedule 1 start now life forever

! Configure thresholds and reactions.
Router(config)# ip sla reaction-configuration 1 react rtt threshold-type immediate
threshold-value 3000 2000 action-type trapOnly

Router(config)# ip sla reaction-configuration 1 react MOS threshold-type consecutive 4
threshold-value 390 220 action-type trapOnly

Router(config)# ip sla logging traps

! The following command sends traps to the specified remote host.
Router(config)# snmp-server host 10.1.1.1 version 2c public syslog

! The following command is needed for the system to generate CISCO-SYSLOG-MIB traps.
Router(config)# snmp-server enable traps syslog
```

The following sample system logging messages shows that IP SLAs threshold violation notifications are generated as level 6 (informational) in the Cisco system logging process:

```
3d18h:%RTT-6-SAATHRESHOLD:RTR(11):Threshold exceeded for MOS
```

This following sample SNMP notification from the CISCO-SYSLOG-MIB for the same violation is a level 7 (info) notification:

```
3d18h:SNMP:V2 Trap, reqid 2, errstat 0, erridx 0
 sysUpTime.0 = 32613038
 snmpTrapOID.0 = ciscoSyslogMIB.2.0.1
 clogHistoryEntry.2.71 = RTT
 clogHistoryEntry.3.71 = 7
 clogHistoryEntry.4.71 = SAATHRESHOLD
 clogHistoryEntry.5.71 = RTR(11):Threshold exceeded for MOS
 clogHistoryEntry.6.71 = 32613037
```

Additional References

Related Documents

Related Topic	Document Title
Cisco IOS commands	Cisco IOS Master Commands List, All Releases
Cisco IOS IP SLAs commands	*Cisco IOS IP SLAs Command Reference*

Standards

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

MIBs

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

RFCs

RFCs	Title
No specific RFCs are supported by the features in this document.	--

Technical Assistance

Description	Link
The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.	http://www.cisco.com/cisco/web/support/index.html

Feature Information for IP SLAs Proactive Threshold Monitoring

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 http://www.cisco.com/go/cfn. An account on Cisco.com is not required.

Table 26: Feature Information for IP SLAs Proactive Threshold Monitoring

Feature Name	Releases	Feature Information
IP SLAs Reaction Threshold	Cisco IOS XE Release 2.1	IP SLAs proactive threshold monitoring capability allows you to configure an IP SLAs operation to react to certain measured network conditions.
IP SLAs VoIP Threshold Traps	Cisco IOS XE Release 2.1	IP SLAs VoIP proactive threshold monitoring capability allows you to configure an IP SLAs operation to react to certain measured network conditions.

Any Internet Protocol (IP) addresses and phone numbers used in this document are not intended to be actual addresses and phone numbers. Any examples, command display output, network topology diagrams, and other figures included in the document are shown for illustrative purposes only. Any use of actual IP addresses or phone numbers in illustrative content is unintentional and coincidental.